BEFORE THE ARIZONA CORPORATION

IN THE MATTER OF THE COMMISSION'S INQUIRY INTO THE EXTERNALITIES OF ELECTRICITY GENERATION, INCLUDING BUT NOT LIMITED TO COST VALUATION OF THE EXTERNALITIES.	) DOCKET NO. E-00000J-10-0053) EXTERNALITIES WORKSHOP) SPECIAL OPEN MEETING

At: Phoenix, Arizona

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BE IT REMEMBERED that the above-entitled and numbered matter came on to be heard at a Special Open Meeting before the Arizona Corporation Commission, in Hearing Room 1 of said Commission, 1200 West Washington Street, Phoenix, Arizona, commencing at 10:13 a.m. on the 9th of April, 2010.

BEFORE: KRISTIN K. MAYES, Chairman
GARY PIERCE, Commissioner
PAUL NEWMAN, Commissioner
SANDRA D. KENNEDY, Commissioner
BOB STUMP, Commissioner

PARTICIPANTS:

For APS:

Mr. Robert Lotts
Mr. Jeff Guldner
Mr. James Wilde
Mr. Patrick Dinkel

For TEP/UNS:

Mr. Phil Dion
Mr. Erik Bakken, appearing via teleconference
Mr. Mark Mansfield, appearing via teleconference
Mr. Andy Hoekstra, appearing via teleconference

For AEPCO:

Mr. James Andrew

PARTICIPANTS:

Guest Presenters:

Mike Pasqualetti, Ph.D., ASU
Benjamin Ruddell, Ph.D., ASU

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CHMN. MAYES: Good morning, everyone. It is good to see you. You are sitting too far back, though. I feel we need to fill in the front seats. So I don't know what is going on here. We have a shyness issue.

But we are here for the first externalities workshop of the Arizona Corporation Commission, in 2010 anyway. It is April 9th. I want to thank everyone for being here. Let me just run through how I thought we would run the meeting today. And then if my colleagues want to make some opening remarks, that would be great.

I think this is a very important and hopefully it will be an informative workshop for the Commission. And we are obviously starting with water, but we will plan on expanding our inquiry into other areas of interest, areas of externalities, including emissions. And so I am really looking forward to hearing what everyone has to say today.

What I thought we would do is start with presentations from the utilities. APS has a formal presentation that it would like to make. I would like to have any other utilities that are here come to the front table so that we can talk so that they can provide comments after APS does. And then what I thought we would is what we normally do, which is go around to everyone in the audience to provide comments or

reactions to the presentations. And the Commissioners will also be reacting to the presentations and asking questions.

Then this afternoon, we have Dr. Mike Pasqualetti coming in from Arizona State University coming in to make a presentation on a study that he has done on water as an externality. And that will be also very interesting. And then we will do the same thing, after Mike talks, we will respond, all of us will respond and ask questions and go from there.

So why don't we begin. We will have APS. I guess Mr. Dodds is here for APS to make the initial presentation. Lotts, sorry. Get you confused every time. It has been a long week, Bob. Please forgive me.

And do we have -- who else from the electric utilities? Okay. Come on forward. We just -- is TEP -- are you from TEP?

Well, hello, Mr. Dion. I thought I saw some folks from TEP.

COM. NEWMAN: We should bring him in the front.

MR. ANDREW: Arizona Electric Power Co-Op.

CHMN. MAYES: Oh, you are from AEPCO. Great.

Mr. Dion? Okay. Great.

COM. NEWMAN: Especially after yesterday's very short presentation from Tucson Electric Power --

CHMN. MAYES: Exactly.

COM. NEWMAN: -- I thought we should put him up front and center.

CHMN. MAYES: Before we get started, Commissioners, would anyone like to make any opening comments?

COM. STUMP: I will if Paul does.

CHMN. MAYES: Commissioner Newman.

COM. NEWMAN: Yes.

CHMN. MAYES: Paul? Anyone?

COM. NEWMAN: Just briefly. I, too, I thank the Chairman for having this meeting day. I think this is the beginning of a very important discussion on the full monetization of costs that are involved in the ratemaking process. And I think it is squarely within the jurisdiction of the Commission to talk about these variables and especially water.

Water in our environment is very important, from a -- clean water, clean air are just two basic values of our society, haven't always been that way but certainly since the 1970s. And there have been a number of studies that I have seen, and I met with a number of people around the country who are really analyzing this externality discussion. I think it is very good that we are doing this now.

I expect it to last a fairly long time in terms of we are not rushing into this. There will be evaluations. We are just taking public comment, getting people's thoughts now. But I perceive that at some point in time, if we are able to get funding, that we might be able to do Arizona related externality funding that also we can make comments on. So this is just the beginning of the process.

And one other thing, this is a good segue into Bob, Bob speaking, but I was up in Jackson Hole, Wyoming at a forum of mostly legislators and some public utility Commissioners. It was at the invitation of actually the new senatorial candidate from the state of Wyoming who, Alan Simpson, Alan Simpson's son, who actually invited me. And I was surprised because my major presentation was going to be externalities, and I thought that would be a very good discussion with legislators and policymakers from around the west. That's who we were. And I did this whole presentation, was all ready to be lined up, and lo and behold, one of the very special sessions I go to, a two and a half hour session, was a professor from Harvard who is basically suggesting that all public policymakers that are in our situation should be looking at externalities, for that matter legislators should be looking at externalities as well, and all the

public utilities.

It is probably one of the more important questions that we have, certainly in this age of trying to figure out what is the best mix for Arizona. We need to know about these externalities. We need to try to make good faith attempts to monetize them, to shape them for our particular situation in Arizona. And I think we will be doing everyone a good public service, that's the consumers as well as the companies.

And I guess that was Bob's segue, but I just want to add one thing. We added a rule, I -- the Commission added a rule, I forget exactly which month it was, but sort of didn't get a lot of public notice, but we have now a rule on the books in our resource planning context that we will be looking at externalities. And I am very proud to say that I authored that and sort of helped to kick off this discussion.

I am also very gratified that Mr. Pierce is here, we are all here, and that it was a unanimous vote to look to externalities. And no matter where you fit in the spectrum of where we are going, I think that we need to discuss this. And I thank Mr. Pierce for engaging in this as well.

And with that, I give it to my Harvard graduate, Mr. Stump.

COM. STUMP: Paul, first you talk about my Hawaii connections and the fact that I went to high school with Barack Obama. And now you are talking about my affiliation with the Kremlin on the Charles, but...

COM. NEWMAN: I am not running against you.

COM. STUMP: I thought we had an agreement of sorts.

Pleased to be here. And of course this is a topic of great importance as it relates to a variety of issues. And I have a series of questions as it relates particularly to the water-energy nexus.

One question, of course, involves the issue of groundwater depletion. Obviously if wells are dug deeper, water has to be lifted higher by pumps. And that requires a lot of energy.

The other issue is one that relates to desalination. This increases the supply of quality water but of course consumes large amounts of power and is, I think, a rather compelling issue as it relates to our existence in the desert. And Herb Guenther, for one, made an interesting comment at a water and energy hearing I attended back in 2009. And he said desalination was, quote, the direction for the state to head, as it is the only drought proof and truly sustainable supply of water available, which I think is

a fascinating comment indeed.

I would be curious to examine, as well, the role for renewable energy in powering desalination efforts as well. I think a certain area in Mexico, whose name escapes me, is working to potentially use a solar array to power a desalination plant. And I think their efforts merit monitoring.

The issue of wastewater as well, that's an emerging new technology, I know, involving microbial fuel cells which potentially can clean up wastewater while generating electricity rather than consuming it, again I think an area of great interest as well.

And lastly, Arizona of course is home to uranium ore deposits, which will be an increasing demand as everyone pushes toward more noncarbon based energy sources. And there is a two-year timeout on a variety of mining claims down in the Grand Canyon and elsewhere. But I have been curious to examine further some of the methods to protect the springs that feed the Colorado River and protect it from contamination, again an issue that relates to the water-energy nexus quite intimately.

So I am looking forward to hearing your thoughts today and pleased to be here as always.

CHMN. MAYES: Thank you, Commissioner Stump. Those are all excellent areas of inquiry, and looking

forward to hearing what the utilities and all the parties who are here today have to say about it.

Commissioner Pierce, did you want to make some comments?

COM. PIERCE: Sure. It has been interesting. Being on the Commission for a little over three years, one of the concerns that I have had and mentioned many times along the way is are we getting the true cost, whether it was water or electricity, whatever it is associated with that commodity.

When I was in the car business, we, you could have two identical used cars on the outside. And I look at water, I mean you could have pure water, and that's your end product. But to get to that point one may have had a lot of problems to get to that point and another one taken well care of. And inside and out it is that way. And I look at, at the end of the day, one of those really cost a whole lot more once you get all the service tickets in with it, but at the end of the day it was a car that could run.

And that's how I look at this, is making sure that all the externalities are in front of us so that we, as decision makers, can really know what is the best deal for ratepayers, what is the best deal for the public, because I think if we don't do that, we are

simply, we are simply avoiding reality. And that's -- I think it is important for us to make sure that we pull all those things into place so that the long-term decisions are based on what the real costs are of the commodity that we regulate and so that we can choose options that make sense. And they may not be the conventional one. They may have to be explained to me. But I think when you line it up and say here are the real costs associated with it, now here is the new bottom line, I think that's, that's fair. And that's what people expect of us. It is good to be here.

CHMN. MAYES: Thanks, Commissioner Pierce. So let me, in the vein of what Commissioner Stump did, let me throw out some questions as well.

And, Mr. Dion, I noticed that you haven't brought your generation experts with you, so it might be a good idea for you to try and get them up here this morning. I don't know if you can make a phone call or two.

But, Mr. Hutchens, you know, we are here, we have an entire Commission seated here and we are serious about this issue.

And I think your legal expertise is second to none, but you don't run your generating units so...

MR. DION: No.

CHMN. MAYES: Could we make a phone call?

MR. DION: Absolutely.

CHMN. MAYES: Great. I would like to know from the parties present today, especially these questions will be particularly pertinent and relevant to the utilities, but I would like to know what the utilities' current water portfolio is; which of their plants use groundwater, to Commissioner Stump's point; which plants use effluent currently; which plants use CAP water; what are the utilities' current plant cooling methods once through; how many cycles for each of those plants; what are the current consumption profiles for the plants under your control per megawatt hour; have you considered pricing water costs internally; what pricing methodology have you utilized if you have priced them internally; have you utilized marginal cost pricing or some other methodology; what are the principal obstacles to implementing hybridized dry cooling at both renewable and conventional power plants, and I think Mr. Lotts is probably going to touch on that; and if the Commission were to price water as an externality, what methodology would we use; what do those present think about the Synapse study which used, I believe, marginal cost pricing, the Synapse study in Utah. And that's it for now. I am sure I will have additional questions.

But, Commissioner Newman.

COM. NEWMAN: Yeah, I really think that Mr. Pasqualetti for ASU, we are lucky to have him. And I am not going to set out a million questions until Mr. Pasqualetti gives his presentation this afternoon. I am not going to reinvent that and sort of waste time. But many of the issues that he brings up are important to me, so listen closely to that presentation.

But I am curious, and this is multidisciplinary sort of questions that we are asking, I am curious about sort of trends in the southwest due to climate change and, you know, really how much the Colorado River water we are going to have, what is the real water status in Arizona. So it is a little bit working with DWR on answering some of these questions. But if we have a decrease in water, if the climate, if the climate keeps on going the way it was but for this year, which happened down in Tucson, it was the wettest year in 60 years, but we are in a 100-year drought still, even though the reservoirs are full, but I am just curious, in that whole context of future decision making context, you know, what is the price of water really going to be. And that's, that's a real tough one.

But the other, I am very interested in cooling. In just about every line siting case I talk about

cooling. And I am still -- there are several states, including Nevada, that actually mandate cooling. And so I realize that it is a little bit extra expense, but I respect my colleagues in Nevada and I want to really dig kind of deep into that a little bit. And that involves the price of water as well as the cost to go to hybridized or dry cooling.

And I know we are working on the water nexus today but there are a number the other issues as this dialogue continues I will have questions about. And that's why I said this is a big topic. It almost makes one need to breathe, you know, take a real deep breath, because we are taking on a lot.

I met with the Synapse people from Nevada who did the study. What is interesting about that, they were not asked by the commission only to do the study. It was a combination of all the different executive departments and the commission. And still they have not gotten feedback on that. They had a meeting, but I have not even talked to the Utah commissioners yet on their take on that study.

But I also think that we should include as partners in this process DWR, DEQ, because they could help us define some of these issues. But I am very, very glad that this many came to this first meeting.

And I look forward to the discussion that I think will be lasting for, you know, past December.

CHMN. MAYES: Okay. Thank you. Why don't we go ahead and get started, Mr. Lotts.

MR. LOTTS: Thank you, Chairman Mayes, Commissioners. Hopefully during this I will answer several of the questions you had, but because I was writing them down I know that there will be more questions and I know you will stop me and ask me questions whenever you need to.

For the presentation that I will go through today, I just want to go through how we use water at our power plants; some alternative cooling systems that we in the entire industry have been looking at; utilization of alternative cooling water supplies, effluent being the one we will look at today; protection of our environment; power plant water use, different types of plants; looking forward, where do we go from here.

Just really starting with the basic concept of how water is used at the plant, we pump the liquid into a system. It is heated by an external heat source. That is turned into steam, which then, in turn, turns the turbine which turns the generator. And then the steam is recondensed by cooling and returning to a liquid state and starts all over again.

So the major purpose of the cooling system is to reject the heat duty from the steam condensation on the atmosphere. There are a couple ways you can do it, and one is a direct cooling system. And this is what is typically referred to as an air cooled condenser, where you reject the steam, the heat, directly to the atmosphere. The other one is through an indirect cooling system where we use the condenser in the middle of this and reject the heat duty through the condenser and then into the atmosphere through cooling towers.

This is a typical mechanical draft cooling tower. You see the cooled water is pumped from the basin through the condenser where it picks up the latent heat, returning the hot water then to the cooling tower. It is sprayed over media and the cool air is sucked in from the bottom of the tower and then rejecting the hot air out of the top of the tower.

Make-up --

CHMN. MAYES: Mr. Lotts, is that, so that's, going back to the last slide, this is for sort of your average conventional combined cycle plant or are we looking at nuclear here?

MR. LOTTS: This is typical of a nuclear power plant, combined cycle, coal. You use this kind of tower for any, any kind of plant.

CHMN. MAYES: Conventional wet cooling?

MR. LOTTS: Yes.

CHMN. MAYES: Okay, thank you.

MR. LOTTS: Make-up water requirements for a wet cooling tower, all the flows, you have the circulating water that comes into the tower system and the circulating water out. Evaporation of the heat comes off the top of the tower along with the drift. You have a blowdown stream to maintain the chemistry in the circ water system and then you have a make-up water that is coming into the system. Your make-up flow rate then is the combination of evaporation, drift and blowdown. Those are all outflows from the cooling tower. And the makeup is our water that comes in.

Looking at different types of cooling systems, you can go anywhere from a total dry system that uses zero percent water to a total wet. Everything in between is classified as a hybrid type of a system. The enhanced dry is like putting a mister system underneath the air cooled condenser to reduce the outside air temperature for the cooling system. And then the plume abated that I have up here, I will talk about that in more detail. It is easier to show you a picture of that one. But I will turn to just the typical wet cooling tower.

100 percent wet is by far the lowest cost solution for a plant --

COM. NEWMAN: Without externalities.

MR. LOTTS: Without externalities, just for building a plant.

-- highest net generation, lowest parasitic power consumption. Parasitic loads are all the loads associated with the cooling system, whether it is fan motors, pump motors, anything that takes energy away from the plant. It also has the smallest footprint for the plant and the highest annual water usage of systems.

This is a 100 percent dry cooling system. This plant is in South Africa. It is six 100 megawatt coal-fired units. And it is totally dry. The dry cooling system usually performs best in cool, humid climates. Retrofitting existing plants are very difficult in that it requires an increased turbine back pressure. And I won't go too far on that at this time. It is a significantly larger footprint than a wet cooling tower system. It has the highest lifecycle cost, and that is the total cost through the life of the plant; and the highest parasitic load; highest new construction cost; lowest net generation, particularly on hot days. Anything above 100 days you start losing efficiency off the plant. And the advantage, of course,

is it is zero percent of the water usage.

CHMN. MAYES: Mr. Lotts, if you could, stay on that plant. I spent three months working in South Africa when I was in college. And it is not a humid climate. It is very much like Arizona's climate. So obviously they found a reason to build this plant.

Is this a merchant plant or is it owned by the South African government?

MR. LOTTS: You know, I don't know the answer to that question, Chairman Mayes. But when I talked to GEA, who was the contractor for this, they said the reason they built it dry was because there was no water.

CHMN. MAYES: Where in South Africa was this built, do you know?

MR. LOTTS: I don't remember. He told me the name of the area but...

CHMN. MAYES: Johannesburg? Okay, I don't want to get that far in the weeds.

MR. LOTTS: You could come up with a lot of names and I would just have the same look on my face.

CHMN. MAYES: Okay. Do you know how much more costly this was to build than the wet cooled alternative?

MR. LOTTS: Between three and five times higher cost to build a dry cooling system.

CHMN. MAYES: Three to five times for any plant or coal or --

MR. LOTTS: That's typical cost, is three to five times. And --

CHMN. MAYES: Go ahead, sorry.

MR. LOTTS: The hotter, dryer the climate the bigger the footprint the dry cooling system has to be. So you just start getting more up on the five times more depending on the climate.

CHMN. MAYES: Okay. Commissioner Newman.

COM. NEWMAN: And I don't want to interrupt that much, but I will try not to, but five times what? Because I have heard it will definitely add cost. Five times of the total cost of the plant?

MR. LOTTS: No, five times of the total cost of the cooling system. That's an excellent question, Commissioner Newman. That's what we are looking at, is five. If I build totally wet versus totally dry, it is five times different cost.

COM. NEWMAN: Right. And that's one of the things that we need to drill down on, because I have, I have talked to a lot of different people. I actually, I was doing research on this a whole year before I got elected, so I have been researching for awhile. And I know it is a higher cost. But I would like to get, you

know, a better number. And I have heard, I have heard diverse opinions about it.

MR. LOTTS: Yeah. And that's, you know, one of the things that we are doing right now is to perform a more in-depth study looking at this environment, specifically the State of Arizona and our climate, and what would that cost be in this area. And, you know, that's the kind of information we really need to be able to make good decisions.

COM. NEWMAN: And I mentioned it before but Nevada, and actually there was a move in New Mexico and New Mexico legislature to mandate dry cooling as well, both environments very similar to ours. But we have a much better deal on our CAP water because of our legacy of congress people who put us in that position. But that doesn't mean that we shouldn't be counting our, counting the water crops.

MR. LOTTS: Yes.

COM. NEWMAN: Thank you. Thanks for that clarification.

MR. LOTTS: So plume abated tower, it is identical to a wet cooling tower with a dry section on top. The possible water savings -- this plume abated tower was really developed to do exactly what it says, to abate the plume off the top of the tower. And there

are a few reasons for it. Some were built at the end of a runway on an airport and so there was a reason for doing that. Other areas that are colder climates, the plume was actually drifting out onto the roadway and causing black ice on roadways. And it was the biggest reason for development of a plume abated tower.

The positive effects of that, though, it has a possible water savings of 10 to 15 percent. It has, it does have a significantly higher construction cost. And this one, I can't tell you what that range is because it depends on the plant and how much water you want to save and those kinds of things, it does have a higher parasitic load. And it has a higher lifecycle cost compared to a mechanical draft tower.

And then this plant is a plant that is in Colorado. It is Xcel Energy. It is a 750 megawatt coal-fired plant. It is a combination of an air cooled condenser and a wet cooling tower. If you want to achieve a water savings of greater than 15 percent, you have to do something beyond the plume abated tower. The investment cost and lifecycle cost is significantly higher. It has, of course, a larger footprint for the plant. And the water savings is dependent on the size of the dry section. So in this plant, they built an air cool condenser that was sized for the plant, so

100 percent dry cooling. And they built the wet side to make up for the losses in the summer. So they built a marginal wet side with a 100 percent dry side.

And I don't have the cost of this but we are working with Xcel Energy to find out what the costs were associated with this system.

So now we will talk about alternative cooling water supplies and what that requires. And I am going to use Palo Verde as an example, because we use effluent there. And 62 or 61 percent of our water that we use for all of our power plants is effluent.

So this is the nuclear power plant. Its external heat source is the reactor.

CHMN. MAYES: Could, I am sorry, but could you go back to that slide. Is that the one -- yes. This is, this pie chart shows your total water use for all of your generating units?

MR. LOTTS: Yes.

CHMN. MAYES: Is this for -- so this is for all the generating units that are owned and operated by APS?

MR. LOTTS: By APS.

CHMN. MAYES: Not necessarily all the generating units from which you purchase power?

MR. LOTTS: That's correct.

CHMN. MAYES: And we might get that information

from Mr. Pasqualetti this afternoon, a little broader look.

So the 61 percent referenced effluent, most of that probably comes from Palo Verde?

MR. LOTTS: Most of that is Palo Verde. Redhawk also uses effluent supplied through Palo Verde.

CHMN. MAYES: So Palo Verde and Redhawk are the two units that use --

MR. LOTTS: That's correct.

CHMN. MAYES: -- effluent?

MR. LOTTS: Okay?

CHMN. MAYES: Uh-huh.

MR. LOTTS: The surface water that you asked about, Four Corners uses surface water. The Sundance plant uses CAP water, surface water.

CHMN. MAYES: So Four Corners is CAP water?

MR. LOTTS: No. Four Corners is --

CHMN. MAYES: It is river water.

MR. LOTTS: River water.

CHMN. MAYES: Colorado River water. Little Colorado?

MR. LOTTS: It is off the San Juan.

CHMN. MAYES: Off the San Juan, Four Corners, right.

MR. LOTTS: Yes, up in New Mexico. Then the

Sundance plant is CAP water. And our Yucca plant down in Yuma is also considered surface water, although --

COM. PIERCE: It is that allocation.

MR. LOTTS: It is that allocation.

CHMN. MAYES: Okay.

MR. LOTTS: So --

CHMN. MAYES: And which plants are on groundwater?

MR. LOTTS: That is our west Phoenix plant, our Ocotillo plant, and our Saguaro plant, and our Cholla plant. There is some groundwater used at Palo Verde. We have about 5200 acre feet of groundwater rights at Palo Verde. We use groundwater for our potable water system because we are pretty remote. We have our own licensed water treatment plant operators out there. And we also use it for make-up to the primary, secondary cooling systems.

CHMN. MAYES: So of the groundwater plant, the plants that use groundwater, west Phoenix, Ocotillo, and Saguaro would be gas plants.

MR. LOTTS: Those are gas plants, and then Cholla is coal plant.

CHMN. MAYES: Coal plant. Okay.

This might be the time for this question. Has APS done a contingency analysis of their plant

operations under extreme drought conditions? I think Commissioner Stump sort of touched on this issue. Have you done an analysis of which plants might have to be backed down or would be threatened under extreme drought conditions?

MR. LOTTS: The ones that would be subject to that right now are Sundance plant, it is on excess CAP water, and our Yucca plant that has fifth and sixth priority rights off the river. So those are the two plants that I am looking at right now to have a different supply available for those plants in case of that contingency.

CHMN. MAYES: So you are analyzing that issue?

MR. LOTTS: Yes. That's my job.

CHMN. MAYES: Okay. That's very interesting. And then the other ones that are on groundwater, though, are you looking at what might happen if the wells that you have for those plants become dewatered as a result of extreme drought?

MR. LOTTS: Yeah. That is the next priority for us to take a look at, is on our groundwater supply. We also want to set up monitoring for our surface water, all of our surface water supplies for the Four Corners plants. So we have real-time knowledge of what the snow pack is up in that area of the country and we will know

if we need to exercise any of our other contracts so that we have a secure supply of water to support those plants.

CHMN. MAYES: Okay. Commissioner Newman.

COM. NEWMAN: I will make it quick and dirty. I would like to see this graph annotated in terms of the questions that the Chair just brought up. It would be helpful.

And I was going to ask you about effluent and -- you know, on top of it. So I have a request to have an annotated graph because I think this is important. And I would like to see such a graph for all the operators. It would be helpful, certainly would.

MR. LOTTS: Yes, that's --

COM. NEWMAN: And on effluent, I recently read the article, in fact, I think Mr. Schultz may be quoted in it, but the new contract that you negotiated, I am not sure who negotiated it, but your company negotiated with the municipalities. And I had always wondered about the price of that water.

And would it be accurate to say that the original effluent contracts with the municipalities were -- I will say it -- was it close to a sweetheart deal or was it a good deal for the cities and good deal for you?

MR. LOTTS: Well, you know, in 1973 when, Commissioner Newman, in 1973 when the cities and the Palo Verde participants entered into that agreement, it was a very different time. And getting rid of wastewater was more of a nuisance than anything else. And we had no value. Reuse wasn't -- we didn't do anything with reuse water at that time. So in the cities' mind at that time, to get anything out of that water was a good deal. And so some people looked at Arizona nuclear power plant participants at that time and said why would you pay anything for water.

You know, times changed and things moved on and it became more of a resource and had more value associated with it. And we both, actually all 12 parties, seven Palo Verde participants and five cities, thought that now was a good time for us to come up with a new agreement.

COM. NEWMAN: And one of the reasons I am asking questions about that chapter, if you would, it gives some insight into market rates for effluent, I suppose, that are more accurate in this year as opposed to the 1970s. But any comments about that?

MR. LOTTS: Commissioner Newman, I -- you know, it is difficult, it was difficult for us to come up with a true market value of effluent. And it varied

depending on the complexity and level of treatment from wastewater treatment plants, the location of them. All those kinds of things really vary the cost of the effluent from the waste water treatment plants depending on where it was.

We thought we all came up with a, the cities and Palo Verde came up with what we thought was a fair market price for the water in this contract.

COM. NEWMAN: It is a huge amount of water. The article stated how much water it was, but, and that's what we are here for to determine as well. That's probably your next slide.

MR. LOTTS: Okay.

COM. NEWMAN: So I will be quiet now, but just an annotation for all the companies would be helpful. And if it is covered in further charts, I will stop right now.

MR. LOTTS: Okay. So at Palo Verde or any nuclear plant that uses this kind of system, the external heat source is the reactor. It heats the water that's circulated through the steam generator. The steam then turns the turbine which turns the generator back to the condenser. And then the cooling system is used to recondense that steam back to water.

At the Palo Verde plant, we use effluent, like I

said. To utilize the effluent and to achieve the management plan goals of 15 cycles of concentrations a water treatment facility had to be built. That water treatment facility, you see the line coming -- I will go into more detail on that plant and its design -- treats the water. Then the treated water is sent out to the two reservoirs. And those reservoirs hold approximately a billion gallons of water. That water is then pumped into the cooling system, the cooling towers here. The cooling towers feed the turbine building. So this flow from the cooling towers into the turbine building is typically around 500,000 gallons a minute. The make-up flow, you know, averages about 45,000 gallons a minute during the course of the year.

When the chemistry needs to be adjusted, which we do on a continuous basis at Palo Verde, we blow the water down to the evaporation pumps and then it evaporates off into the atmosphere.

Because typically power plants and wastewater treatment plants aren't collocated, a conveyance system is built. This one to Palo Verde is a little over 36 miles long. It is gravity from the 91st Avenue plant to the pump station, which is located on the Hassayampa River. And then the last eight miles is uphill about 150 feet into the plant.

COM. NEWMAN: Madam Chair.

CHMN. MAYES: Commissioner Newman.

COM. NEWMAN: Real quick. I think it is a good enough time. It is a good time to ask this question as well. I am going to be briefed in the first week of May a little bit more on your nuclear operations and perhaps future plans, but I am going to ask a question now. So might as well be ready for it in May and ask it of you.

When I read the article about the purchase of the water at a higher price, what went into my head was what if. And I think what if -- strike that. But what if we, APS and SRP and other players came up with a proposal to expand? And what, is there enough water to cool more towers -- more units? I mean this is sort of a nuclear engineering question and I am just curious about it. You understand why I am asking?

MR. LOTTS: Commissioner Newman, the supply we negotiate is for Palo Verde. And it meets the needs of the Palo Verde plant.

COM. NEWMAN: Present at Palo Verde.

MR. LOTTS: As it exists today.

COM. NEWMAN: Okay. And so in the spirit of future resource planning and trying to monetize things, you would have to find an alternative water source or ag water or native American water or how?

MR. LOTTS: For any new base load generation we would put in place that uses water, we would have to find a new source of water.

COM. NEWMAN: And what are the company's plans?

MR. LOTTS: For finding new sources of water?

COM. NEWMAN: Yes.

MR. LOTTS: You know, we are always looking at water sources that are available but typically don't make a purchase unless you know what it is you need. I don't know a better way to say that. I mean if you needed -- we just need the margin to keep up with our current generation right now.

COM. NEWMAN: Because I am a novice, well, a novice in sort of purchasing water for power, the -- oh, it happens.

MR. LOTTS: I have broken it.

COM. NEWMAN: The other water sources would be?

MR. LOTTS: You know, there is multiple different water sources that are available from some groundwater which is brackish groundwater. There is, as we continue to build in the state, there is more effluent that becomes available. There is the ADD water process that CAP has gone through which talks about new water supply coming into the state.

There is not much surface water but the majority

of the water in the State of Arizona has been spoken for and utilized by all of its -- everybody who needs water currently. So it is a very complex issue to go out and acquire new water.

CHMN. MAYES: To this point, Commissioner Newman.

COM. NEWMAN: Please.

CHMN. MAYES: And then we probably need to finish and continue on and finish up.

But would it be fair to say, Mr. Lotts, that APS, and I will ask this of the other utilities, when it is seeking out new sources of water, will not be seeking out groundwater as a new source of water? Are you considering groundwater as a new source of water for a new power plant?

MR. LOTTS: Well, I mean I am not really looking at a new supply for a new power plant. But we are looking, we look at all the alternative water supplies, and not only from cost but mining groundwater and political atmosphere of things and what is the right thing to do. So I don't want to say we are not considering groundwater because, you know, you always have to look at the entire water portfolio and what that looks like, but we also live in this state and we want to do the right thing also.

CHMN. MAYES: Right. And from my standpoint as a regulator, I frankly, you know, if we had a combined cycle plant come in front of us again, one of the questions I would ask would be I would like to see DWR's 100-year ground water supply reports, because I am increasingly concerned that the GRD system that we currently operate under really has way too many loopholes in it. And, you know, we could end up siting power plants in parts of the Phoenix AMA that are going to become dewatered because of this GRD system that allows you to withdraw water in one area and replace it all the way across the AMA. And it is, it is a disaster waiting to happen, I think. So I think this Commission and future commissions are going to have to take a very close look at where these power plants are in place.

MR. LOTTS: Chairman Mayes, I would say that would be a good challenge for anybody who comes before this Commission.

CHMN. MAYES: Okay. Thanks.

COM. NEWMAN: Thank you, Madam Chair. I think that's, that's the kind of information that is fantastic. I am glad you are talking about it.

MR. LOTTS: So the treatment facility is a 90 million gallon a day water treatment plant. It is called a tertiary treatment facility, where you take the

effluent, secondarily treated effluent from the SROG cities. So it is the Sub Regional Operating Group, which consists of Phoenix, Scottsdale, Tempe, Mesa, and Glendale. And we also have a supply of effluent that comes from the City of Tolleson. This facility is designed to reduce ammonia, reduce hardness and polish the water before it is sent out to the reservoirs.

The water use at Palo Verde in 2009 was 738 gallons a megawatt hour. The total water use for Palo Verde during 2009 was 69,405 acre feet, or about 22.6 billion gallons of water. Our cycles of concentration are greater than 25. We have a performance metrics on the plant that says this is our baseline on what we think we can achieve or what we should be able to achieve at the plant. That equates to a total dissolved solids parts per million in the circulating water system between 25,000 and 29,000. And we don't exceed that because we have an air quality limitation of 30,000 ppm of TDS per month. So we have to maintain our concentration below that.

COM. NEWMAN: Madam Chair.

CHMN. MAYES: Yes, Commissioner Newman.

COM. NEWMAN: I just want to for the record get an explanation. Any hydrologists in the room? But you are the closest one and I will ask.

70,000 acre feet is a lot of water, I know. But I always like to try to analogize how much that is. You know, compared to all the other uses of water, when you see it in black and white, it looks like, even though it says 22.6 billion gallons, you still -- you know, that sounds like a lot. It is hard to put it in, put a volume in the context of this room or how big it is.

When I worked in Cochise County and we had a 100-year flood and the county hydrologist said, you know, at the rate that this was going, it was sort of like the water down the wash, it was almost like a missile going so fast that, you know, you can be like five miles away in like two seconds. You understand?

I mean, is there a way that you can tell us what 22.7 billion gallons really is?

MR. LOTTS: One of the things, Chairman, or Commissioner Newman, that we tried to put it into context, because this is a big number how do you wrap your head around how many gallons that is, I think our calculation was it would fill up Bank One Ballpark 1600 times.

COM. NEWMAN: That's the kind of thing I was looking at. That's amazing.

MR. LOTTS: That's from the plant, or maximum flow rate through this plant would fill a typical

swimming pool in about 15 seconds. But the other aspect of that, and we will get to later, is the total state's water budget and put it into that context as well. But, yes, it is a --

COM. NEWMAN: Just a final statement. How many Bank One Ballparks?

MR. LOTTS: It was about 1600.

COM. NEWMAN: Thank you.

MR. LOTTS: You are welcome.

The blowdown stream that I mentioned earlier is the waste stream that goes out to the evaporation pond. So about 3,000 acre feet per year or about 5 percent of that total make-up water is sent to the evaporation ponds.

We have three evaporation ponds. Their nominal size is 250, 220 and 180 surface acres. And they are nominally 30 foot working depth. Evaporation rate in this state is, or in this climate, is 60 to 72 inches per year. So when all three evaporation ponds are in service, that equates to between 3250 to 3900 acre feet per year evaporation. So you will see that we have some redundancy on all of our impoundments now.

And pond number 3 is actually under construction when this photograph was taken. That has been completed. Pond number 2 is currently being

rehabilitated or relined. The liners are 60 mil HDP, high density polyethylene, liners and they last about 20 years. So every 20 years you reline the impoundments.

So using an alternative water supply does come at a cost. And our production costs or the piece of our production cost that is seen at the Palo Verde facility at the water reclamation plant is a total of 1.19 per megawatt hour. And the chart breaks down all the cost elements that we have from raw water cost to manpower and chemicals for treatment, are the three main costs that we have at that plant. So --

CHMN. MAYES: Commissioner Newman.

COM. NEWMAN: Yes. So the 34 percent effluent costs, that was done before the renegotiation?

MR. LOTTS: No. This is what the cost will be with the renegotiated price.

COM. NEWMAN: With the renegotiation?

MR. LOTTS: Yes, that's correct.

COM. NEWMAN: And what was it before, may I ask?

MR. LOTTS: It was about 10 percent of the cost of operating a plant before.

COM. NEWMAN: So now I can ask the question that I wanted to ask since I read the article in the newspaper. How are we to treat this in the rate base

without a new rate case? I mean, will this cost come to us in the new rate case down the road, or are you going to eat it?

MR. LOTTS: Mr. Edington is looking at efficiencies in the plant --

CHMN. MAYES: Hang on guys. For the court reporter, we can't be talking over each other. We had troubles with this yesterday.

COM. NEWMAN: Okay.

MR. LOTTS: Mr. Edington is looking at increasing the efficiency of the plant to try to absorb this cost into the normal operating expenses of the plant right now. That is his -- what he has said.

COM. NEWMAN: And then the final question that I would have asked if Marty were with me when I was reading the article was how much more money now do you spend for effluent than before? Again it was an article but...

MR. LOTTS: Annually? I mean it escalates over time. So it is about a little over double, two and a half times where we currently are, and will continue to escalate. The previous contract had a $30 cap on it and it wouldn't escalate above that. And this one will continue to go up.

COM. NEWMAN: And I take it from your answer

that you will be seeking some amendment to the rates in the future based on that analysis, or you are going to, not eat it or drink it per se, but try to limit that number in the interest of consumers' pocketbooks?

MR. LOTTS: You know, I don't know the answer to that question, Commissioner Newman.

COM. NEWMAN: Well, I will certainly try to limit that number in the interest of consumers' pockets. Thank you.

MR. LOTTS: In 2005, a new storage reservoir was built. And this reservoir was built because the liner life and the 80 acre storage reservoir had come to the end of its useful life. And since only one reservoir was constructed with the plant, a redundant reservoir was constructed at this time. The design on this reservoir was really the state of the art design, too. Although, the water in our storage reservoir is clean, we wanted to continue to protect the environment.

So this reservoir has 10 to 12 inches of soil cement on the side slopes. It is dual lined with a collection system leak detection system. And it returns any water that leaks through the liners and back to the reservoir.

The evaporation ponds, the new designed evaporation ponds are very similar to this except there

is an additional liner that is under the two high density polyethylene liners, geosynthetic clay liner, and it just adds one more layer of protection.

The quality assurance program that we use during the construction process is spark testing to identify any flaws in the liner as it was put down. We also did destructive testing to insure that the tensile strength and elasticity of the material was what our specifications -- met our specifications.

We do pressure testing and vacuum testing on each one of the seams. These sheets of liner are 34 feet wide. So with a very large 90 acre surface area, there are multiple seams, and you don't want any leaks once you start putting water into these impoundments.

Our groundwater monitoring program that exists at Palo Verde is extensive. But our other plants are very similar to this. We monitor the shallow aquifer that exists at Palo Verde as well as the regional aquifer and everything in between. We want to make sure that we don't do anything that would contaminate our drinking water supply in the state.

Now we will talk a little bit about typical energy consumption. And this slide was put together by Water Environment Federation. And it goes from raw

materials all the way to transmission and distribution, thermal electric fuels, from coal, five to 70 gallons a minute. And it is, as you see, oil and natural gas varied so much that they didn't even put a range on this one. And uranium was 45 to 100 gallons per megawatt hour. And then the other ones don't have the raw material cost. Thermal electric generation, they have their range from 190 to 720 gallons per megawatt hour; although, we know our nuclear plant in the desert southwest exceeds that by a little bit.

Evaporative loss often of hydroelectric, they have it as 4500 gallons her megawatt hour, but of course that varies with climate and size of impoundment. Geothermal is 1400 gallons a megawatt. Concentrating solar, we have 750 to 820. And I have seen numerous reports on what those plants will use. And since we don't have one in this area yet, we don't know how accurate those numbers are. Photovoltaic and wind are both minimal water users.

This --

COM. NEWMAN: Madam Chair.

CHMN. MAYES: Yes, Commissioner Newman.

COM. NEWMAN: Thank you.

Would you mind going back to groundwater monitoring on page 22. I was listening to you, and I

basically got that you do extensive monitoring at wells. And I started looking at the legend and something called piezometer.

MR. LOTTS: Piezometer.

COM. NEWMAN: A piezometer. And whenever I don't know a word, I feel like asking. And I don't know how many people in the room know the word, but that is a piezometer?

MR. LOTTS: Commissioner Newman, that is for a shallow well, to give an early indication of any kind of water migrating into that area. And so you would then look for where the water is coming from, what is the source of the water, is it coming from one of the impoundments or is it rainwater flow that's migrated into that well. So it is an early indicator.

COM. NEWMAN: And do you work with the Nuclear Regulatory Commission on this or is it with the state DEQ authority?

MR. LOTTS: DEQ is our regulatory agent. We work with them very closely in coming up with our aquifer protection permit and our groundwater monitoring plans.

COM. NEWMAN: And do they -- how many inspectors do they have working with you, or do they take your word for it?

MR. LOTTS: No, they don't, believe me. Commissioner Newman, believe me, they don't take our word for it, and they shouldn't. They come out. And we send in reports and they come out and monitor the plant and look at what we are doing, and challenge us as well.

COM. NEWMAN: So, and it is not -- it is DEQ, it is not EPA. But they have a plethora of EPA rules that are enforced by DEQ.

MR. LOTTS: That's correct.

COM. NEWMAN: Have there ever been any leaks into the groundwater?

MR. LOTTS: Any -- we did have -- into the groundwater?

COM. NEWMAN: I am asking because I am --

CHMN. MAYES: We kind of need to stay on focus.

COM. NEWMAN: No, no. I am asking because this is a cost of water, too, I mean monitoring the groundwater, how much does it cost to do that.

Have there been some problems? Have you had to do remedies that might cost more, that kind of thing? People don't realize --

MR. LOTTS: We did --

COM. NEWMAN: -- especially when you are dealing with this kind of water.

MR. LOTTS: Commissioner Newman, we did have a

tritium that was identified around one of the units. Actually we did extensive testing around the units. We were able to find the source and contain it and mitigate any impact, but it did not get to the groundwater. So that's, that's our plan, is to do early monitoring in our plant and extensive wells so that there is no impact to the groundwater.

COM. NEWMAN: And, okay. Well, I will leave it there, but I had to ask a couple more questions. Thanks.

MR. LOTTS: Again our water usage, and we will annotate this graph and get that to you. Our power plants' water usage of course in 2009, like I said earlier, Palo Verde was 738. Our coal plants' average was 548 gallons of megawatt hour. Our gas plants were 382.

CHMN. MAYES: Mr. Lotts, you don't obviously yet have any CSP plants, but could you give the Commission a sense where CSP comes in? It is, what, in the 700 gallons range, maybe even 800?

MR. LOTTS: Chairman Mayes, I have heard anywhere from, anywhere from 700 to a thousand. So I don't have a better number than that at this time.

CHMN. MAYES: Okay. Does APS have -- you do have an analysis of what Solana will use?

MR. LOTTS: And that number was somewhere around 8- to 900 gallons per megawatt hour.

CHMN. MAYES: Okay.

MR. LOTTS: Once it gets, once it gets built, we will know exactly what it is.

CHMN. MAYES: Okay. Thank you.

MR. LOTTS: This is 2008. That's why there is a different number for nuclear, it is not a different plant, 759 gallons a megawatt hour in 2008. This is a combination of APS, SRP and TEP plants. So we looked at all of them to see what is the average for our water use for our plants as a state. And they are relatively similar to what we saw just in the APS plant, 577 in coal and 325 in our gas plants.

And this is a pie chart from Department of Water Resources on the total state water budget. And so you see, of the 6.1 million acre feet total of the state, that 400,000 acre feet is used for industrial. And then if you break that industrial down further, you see that the total power plant water use, and this is APS, SRP and TEP again, is about 180,000 acre feet of the total 6.1 million acre feet that we use in this state.

COM. NEWMAN: So, Madam Chair, just a brief question.

The huge budget for, the huge budget for ag

business is, I have seen this chart before, but it really is an exclamation on what they are holding. These are reserves of agriculture work or active agriculture work or just designated agriculture use?

MR. LOTTS: Commissioner Newman, I believe this is what is reported used to our Department of Water Resources.

COM. NEWMAN: Used.

MR. LOTTS: I believe.

COM. NEWMAN: Used. That's what I wanted to clarify, ag business now. Thank you.

MR. LOTTS: So our total usage for generation is 3 percent of the total state's water budget. And this, like I said, this is 2006 Arizona state water budget and 2008 power plant water usage.

So to kind of summarize it and looking forward, of course, I think we all understand that water and energy are interrelated. Conserving one conserves the other. Promoting water and energy conservation is something that needs to happen in our state and, actually, across the United States. Identify alternative cooling strategies, looking at what is the practical application in our desert environment, is it a combination of wet, dry, hybrid kind of plants and towers. And that's what we need to be looking at,

identifying alternative cooling water resources and using the right water for the right use; looking at utilizing impaired water, whether that is brackish groundwater or effluent or some other source of water that would need extensive treatment to make use as potable water and conserving that higher quality water for the potable water supplies in the state. And then, lastly, you know, in the future we will require all of the stakeholders to work together to balance the environmental concerns with the total cost impacts to our area.

CHMN. MAYES: Thank you, Mr. Lotts, appreciate the presentation.

I wanted to ask you a couple questions. And these questions will be also for anyone present today when we go to the comment period.

Given the fact that APS has estimated that the state's growth and APS' load could double over the next 20 years or so, I think the figure that you have thrown out in the past is 16,000 megawatts to 32,000 megawatts, well, that's for the state I guess, but you certainly are projecting significant growth into the future, doesn't dry cooling or renewable energy almost have to be -- renewable energy, particularly those forms that don't use water -- have to be a part of the answer as

well as energy efficiency? And have you -- well, let me ask that first question. Then I will have a follow-up.

MR. LOTTS: I want to look at what we are in the process of looking at, Chairman Mayes, is what is the best cooling alternative that gives us the most, the best -- makes the best economic sense. If you go with total dry cooling, it may be the right fit for some applications. It may not be the right fit for every application. And so that's why currently we have a study in progress to look at what makes the most sense in the State of Arizona and whether that's totally dry or a combination of wet and dry.

CHMN. MAYES: Okay. Mr. Guldner is going to join you because these might be more policy oriented questions. But I had a second, follow-up question.

APS' resource plan states that the company intends to move toward non-wet cooled technologies. There is a bullet point in your resource plan on that. There is nothing more specific than that. What is the time frame for that assumption, Mr. Guldner or Mr. Lotts?

MR. GULDNER: Chairman Mayes, Commissioners, Jeff Guldner from APS. And if -- do you want me to go back?

CHMN. MAYES: Sure.

MR. GULDNER: Let me go back to the first question because I think, as you know, we have got different areas of specialization within the company. And Mr. Lotts is, I know, passionate about the water side of it, but obviously it rolls up into a much broader resource planning picture.

And I think, I think your comments were right on the mark, that as you look at the mix you can look within that water component at how do we get more efficient at using water, what are the right mixes for the technologies. But then you can step beyond that into the broader picture and say what role now does energy efficiency play in reducing the need for consumption, what role do nonwater-using renewable technologies like photovoltaic, solar, wind, how do those now fit into that equation. And then to the extent, as you know, we have got base load resource need in the future, the need to put some additional base load resource in, that's when you start getting into the question now with that "do you add the water" piece of the equation.

Just something that is happening now at the federal level, this question, how do we integrate more variable energy resources like wind and solar, and what is that causing to systems, generally you need to put

some peaking capacity, some gas turbines or some combined cycle combustion turbines or combined cycle components to regulate the system because the renewable resources create more variable impacts on the system. So there is a water component to that right now unless it is totally dry cooling. They all have to tie together in the analysis.

We have got -- Jim Wilde is in the audience. I know he is our resource planning director. He can probably give you more specific answers of when we see different things in the actual resource plan. But I certainly agree with the broad policy perspective, which is this is a piece of it, the water component, and within the water component is a piece of it, but there are a lot more things that we have to consider as well.

CHMN. MAYES: Okay. Thank you, Mr. Guldner.

Mr. Wilde.

MR. WILDE: Good morning. Jim Wilde, APS.

Chairman Mayes, Commissioners, we are in the process right now of reevaluating our resource plan going forward. So in the resource planning process, we will go into more detail into these discussions, but for right now, we don't anticipate the need for, say, a new combined cycle unit for sometime into the future. And if we did, the assumption that we are using in our

planning is dry cooling.

So I am hoping that gets to the question of what you were wanting to. And we will go into more detail as we evaluate the plan.

CHMN. MAYES: So as you -- Mr. Wilde, do you know -- you don't know yet at what year you hit the need for a new combined cycle plant or a --

MR. WILDE: Right now it looks like combined cycle would probably be outside of that 15-year planning horizon, so it is sometime into the future.

CHMN. MAYES: Okay.

MR. WILDE: And base load, we have, it looks like, a base load need sometime in the mid 2020s kind of time frame, '24, '25, in that time frame.

CHMN. MAYES: Base load is '24?

MR. WILDE: '24, '25 time frame.

CHMN. MAYES: 2024, 2025?

MR. WILDE: Correct.

CHMN. MAYES: Okay. And, but for base load, the planning horizon for that would start much, much sooner than that obviously?

MR. WILDE: Would start much sooner than that, that's correct.

CHMN. MAYES: Okay. And for base load, are you making the same dry cooling or hybridized dry cooling

assumptions?

MR. WILDE: I think Mr. Lotts would probably be better to answer that specific question in terms of the technologies.

CHMN. MAYES: Okay.

MR. LOTTS: That's the technologies study that I have in process right now, is to look at what are the best alternatives we can use that give us the most efficient operation and looking at the economies based on that.

COM. NEWMAN: Madam Chair, just to that point.

Are you using outside experts or are you doing this in-house?

MR. WILDE: We are using outside experts to help us with this.

CHMN. MAYES: So I would assume -- thank you, Mr. Wilde, appreciate that.

MR. WILDE: Thank you.

CHMN. MAYES: That was good insight. You were using, you are doing a study to assess dry cooling on base, future base load plants?

MR. LOTTS: Yes, future base load, different kinds of plants, whether it is any kind of plant.

CHMN. MAYES: Which would include nuclear?

MR. LOTTS: Just any kind of plant.

CHMN. MAYES: Okay. Mr. Guldner, which would include nuclear, right?

MR. GULDNER: I think it would. I think it would. That's one of the things, I don't think there has been a dry cooled from a technology standpoint.

CHMN. MAYES: Hybridized dry cooling?

MR. GULDNER: I am not sure there has been one of those. I think it is a licensing issue in the U.S. as to how you go about doing that. But actually, if I could, Chairman, I wanted to come back maybe to a question that Commissioner Newman mentioned earlier, which was the rate, how does this fit in the rate impacts. And maybe just to try to clarify, the Palo Verde water contract is a good example.

As we build our cost of service case together, we put in all the different costs. So, for example, lime is required at power plants to do pollution control. Water is required at power plants to do cooling. And so those all come in as expense.

And so what typically happens then is the Commission Staff and the consultants and the parties look at whether our decisions were prudent and then whether those should be included in the either rate base for capital assets or expense from an O&M standpoint. And then that's how it is picked up in rate case.

So to the extent a component increases in the next rate case, that will come through in the cost of service study and, you know, people would come in and perhaps say was this a prudent decision or not. And I think what Mr. Lotts said internally what the company may be trying to do and what Mr. Edington is trying to do, how can I offset some of that higher cost by lower expenses, the expense is still going to show up so you may have lower expense here, higher expense on the water side, and try to offset those.

But just to be clear, when that study comes out and you see those expenses, they are still going to be in the cost of service study.

COM. NEWMAN: Well, and just in response to you, I was a bit tongue in cheek saying I am going to take a close look at that, but I understand that qualification.

CHMN. MAYES: So, Mr. Guldner, while we still have you, and then I have got somebody from TEP on the line for my colleagues to ask questions of, but have you considered pricing water costs internally? And if so, what pricing methodologies have you used, and have you considered marginal cost pricing?

MR. GULDNER: I am waving for Mr. Wilde to come up because, yes, I know we do consider water. That's part of when we do the revenue requirement analysis for

different resources, both the technology such as dry cooling, what additional cost does that have, but just the cost of the water piece of that.

CHMN. MAYES: Okay.

MR. WILDE: Chairman Mayes, Commissioners, water is included in all of the studies that we do. And we get the costs from Mr. Lotts. And that's all incorporated into what we do.

CHMN. MAYES: Well, but how do you price it? I mean, do you do marginal cost pricing or do you do just what the price is, what the first unit cost is?

MR. WILDE: We use the contracts we have available.

CHMN. MAYES: Which would be different than marginal cost pricing --

MR. LOTTS: Yes.

CHMN. MAYES: -- which was done in the Synapse study.

MR. WILDE: Yes.

CHMN. MAYES: Okay. So you don't do that.

MR. WILDE: We do not. We use the contracts we have available.

CHMN. MAYES: All right. So if there are -- thank you, Mr. Lotts, appreciate that excellent presentation.

If there are no other questions for APS, why don't we move to TEP and then we will come back to AEPCO.

Mr. Dion, you have an individual on the line for us, I understand.

MR. DION: Madam Chair, Commissioners, just for the record, Phil Dion, vice president of public policy for UniSource Electric Corporation. And I do have more than one. I have three individuals, Mr. Erik Bakken and Andy Hoekstra and Mark Mansfield who will be listening in; although, they should be on mute. So they can go ahead and undo it if they were listening. And if they speak, if they please identify themselves for the record.

Madam Chair, just quickly, one of the things I did want to mention is regarding the public policy of this. Some of the things that we at TEP have looked at besides the individual water usage and power plants is in our renewable policy. As this Commission knows, we have looked at solar photovoltaic and, up in UNS Electric's service territory, wind. And we have identified those projects as good projects. One of the things that we did consider is the water usage.

Additionally, this issue is broader than just the power plants for us. One of the things that EPA is

looking at currently is particulates and particulate matter. And we may get a couple more counties in Arizona that go nonattainment. And Pinal is one of them, Pima, and actually a couple other service territories as well that we are looking at.

So some of the things that we are looking at are outside of the -- also affect the water usage because in those areas, especially in the rural areas, folks use water to keep the particulates down, especially on the paved road, excuse me, on the nonpaved roads. So one of the things that we are looking at is looking in those areas, seeing what we can do in those counties, paving perhaps some of those roads, kind of get a "two for," if you would, save water and we also get to work within our -- the particulates that are in each individual zone. So it is a, it is a -- we are taking a global solar look at water.

But the experts, such as they are, are on the phone and they are available for questions.

The other thing I would say, my understanding is the Commission might come down to Tucson for an externalities open meeting down in Tucson. And we would certainly have a similar presentation that APS did this morning, perhaps with some more insight what is going on after this one. But that's, that's up to the Commission

and we are just making ourselves available.

CHMN. MAYES: I should certainly hope so. And I would expect, since the Commission is coming down into your service territory to discuss externalities, that you will be there and your people will be there in person to provide this information to us. So...

MR. DION: Absolutely, Madam Chair.

CHMN. MAYES: Okay.

COM. NEWMAN: Madam Chair, just quick.

CHMN. MAYES: Can I --

COM. NEWMAN: Yes.

CHMN. MAYES: If I could just start by asking a few questions. And the individuals on the phone are generation experts?

MR. DION: Yes, Madam Chair, as well as environmental.

CHMN. MAYES: Okay. And I guess, you know, what I would like to get from your folks is the same information that APS provided with regard to its generation fleet, you know, and in particular what plants use groundwater and in what percentages, what plants use effluent and in what percentages, what plants use CAP water and in what percentages, what are your current plant cooling methodologies and what is your position -- this may be for you, Mr. Dion -- on pricing

water costs internally and in particular marginal cost pricing.

MR. BAKKEN: This is Erik Bakken. I manage the corporate environmental services department. I also have with me the vice president of generation, Andy Hoekstra, as well the general manager of energy resources, Mark Mansfield.

In terms of our water resources at our generating facilities, we have a variety of resources that we use at our remote plants. We have surface water usage as well as effluent in one of our plants in New Mexico. For those plants that are operated by TEP, we primarily use groundwater resource.

In terms of our current plant cooling methods, primarily we use traditional wet cooling towers. And our consumption profile at this point on average throughout our system is approximately 5- to 700 gallons per megawatt hour.

If would like more specifics than that, I would be happy to answer any other questions that you might have.

CHMN. MAYES: Sure. And could you be specific? We have a court reporter. This proceeding is going to hopefully lead to something, so we want to be as specific as we can.

Can you tell us, as I said, which of your plants use groundwater, which of your plants use effluent, which of your plants get CAP water. And you have said all of your plants use wet cooling. I guess that answers that question, but...

MR. BAKKEN: Yes. In a little bit more detail, like I mentioned, the plants that TEP operates, which would be our Sundt generating station; Springerville generating station; Valencia, which is operated by a subsidiary of UniSource Energy Corporation, UniSource Energy Services; Black Mountain generating station, are groundwater water resource, use groundwater resources.

Our remote plants at Four Corners, San Juan, and Navajo, our interest in those plants is primarily surface water. And another gas-fired plant in New Mexico, Luna generating station, has a mixture of both effluent and groundwater water resources that are utilized.

CHMN. MAYES: Okay. And then APS presented a chart. Thank you for that. APS presented a chart to us that I would like TEP, UniSource to duplicate that, provide percentages of its overall fleet for effluent groundwater or surface water. And can you, so can you calculate the percentages, can you calculate the water usage by percentage?

MR. BAKKEN: Yes, you know, I think we could do that. Again, I apologize for not being there in person today. But with just a little bit more analysis I think we could certainly come up with that type of information for you.

CHMN. MAYES: Okay. And I know my colleagues have questions. But are you examining -- it sounds like APS is undertaking an examination of a hybrid dry cooling or dry cooling on both base load and combined cycle plants. Is TEP engaged in any similar analysis?

MR. BAKKEN: Yes. To the extent that we have plans for expansion of any of our generating facilities, we are taking a look at the possibility and the probability of using dry cooling techniques. And that would be done in conjunction with an outside third-party expert.

CHMN. MAYES: So you also will have that, a study underway?

MR. BAKKEN: That's correct.

CHMN. MAYES: Is that part of your resource planning process?

MR. BAKKEN: Yes, it would be.

CHMN. MAYES: Okay. And are you making an assumption, as it would appear APS is, that any future generation, especially combined cycle, would be at least

hybridized dry cooling?

MR. BAKKEN: That is one of the alternatives that we are looking at, that's correct.

CHMN. MAYES: Okay. So you are not making that assumption that it would be -- I am sensing a difference between TEP and APS on this issue.

Mr. Dion.

MR. DION: Madam Chair, I think the answer of APS is similar to the one that Mr. Bakken is giving you, essentially that we would look at the economics of it but that if -- one of the things Mr. Bakken just spoke about is we are looking at it as very probable in the future for the licensing of a new plant, especially by this Commission. It is certainly entered into the queue of things that we are thinking of. But I think we would view it as something very highly probable.

CHMN. MAYES: Commissioner Newman, did you have questions?

COM. NEWMAN: No. It was more procedural than anything else. I thank the gentlemen for being on the phone and I thank Mr. Dion for bringing them here. And I just, it was -- I just wanted to be part of the record that we had a discussion in our Staff meeting this past week about the Tucson meeting in which, you know, we are hoping to have water, eminent water experts, both Sharon

Megdal and the law professor from ASU -- Kris, you have to tell me. Not Pasaualetti. The U of A law professor.

CHMN. MAYES: Oh, Glennon.

COM. NEWMAN: Mr. Glennon, Dr. Glennon. Professor Glennon is also going to be there to supplement this record. And I was looking forward -- I can't believe I forgot his name, but just that kind of morning. But he has just written a national best seller, international best seller book on water. It is the water-power nexus. And water in general is very good. And I wasn't sure if TEP was going to be there to give presentation. But it would be a very, very good thing if they did down there as well for the Tucson folks. And we are still trying to figure out how to include perhaps that into this record. That's all.

So hopefully we will be able to sort of supplant that record with what, with -- this record with what is going on in Tucson as well, not to duplicate but to take into account people's schedules and also get the externality discussion on the water-power nexus going on in southern Arizona as well. And I was doing my best to convince all the Commissioners or as many as possible to attend that, especially my friend Commissioner Pierce. Thank you.

CHMN. MAYES: Mr. Dion, if the Commission were

to price water as an externality, what methodology should we choose? What is TEP's position on that? And then I don't know if he, if I asked this of Mr. Guldner, but I would like Mr. Guldner to respond to that as well. And then I am going to open it up to the audience.

MR. DION: On --

CHMN. MAYES: While you are thinking about that, let me ask you another question.

MR. DION: That's a tough question, Madam Chair.

CHMN. MAYES: Has your utility done a contingency analysis of its plant operations under extreme drought conditions, what plants might have to be backed down or could be threatened under extreme drought conditions?

MR. DION: And, Madam Chair, I will follow my good friend Mr. Guldner in getting the real experts on the line, are actually on the line for that one. I know we have done that but I would really like to talk to Mr. Hoekstra, our vice president of generation, or probably Andy would be the best one to answer that question.

CHMN. MAYES: Okay.

MR. DION: Did you hear that question, Andy?

MR. HOEKSTRA: Yes, I have. Those studies were primarily done at our participant facilities at Navajo,

San Juan primarily relative to possible drought conditions. It also involved the -- it primarily evolved around, for instance at San Juan, of being able to, during drought conditions, being able to have alternative water sources.

One of them that is being studied currently is effluent from the City of Farmington, also being able to obtain water rights from neighboring tribal communities, and also, in the case of the Navajo generating station, relative to water levels in Lake Powell and the ability to access those, the water levels at lower levels.

CHMN. MAYES: Because you get water out of Lake Powell?

MR. HOEKSTRA: At the Navajo generating station, correct.

CHMN. MAYES: Okay. And so your contingency studies have examined what you would have to do in the alternative if water levels continued to decline at Lake Powell?

MR. HOEKSTRA: Correct.

CHMN. MAYES: Okay. So this is very interesting information. I have never heard this before. And I think it is fascinating actually. It is why we are doing these workshops.

So it sounds like the utilities have done these

contingency analyses. And I guess my next question for Mr. Hoekstra is: Have you analyzed the cost of achieving those alternative supplies of water? I assume if you are going to get effluent from Farmington that involves bringing in a pipeline from Farmington.

MR. HOEKSTRA: Correct.

CHMN. MAYES: And what is the cost of having to bring in a pipeline and buy effluent from Farmington, which presumably is going to price that such that it benefits the City of Farmington?

MR. HOEKSTRA: You know, I don't have those numbers available.

CHMN. MAYES: That's okay, Mr. Hoekstra. Can you supply that study to the Commission?

And I would ask the same for APS, any drought contingency studies that it has done on its generating units.

Mr. Dion, can you do that and supply it to this docket so the public has access to those studies? Mr. Dion?

MR. HOEKSTRA: Yes, we can.

MR. DION: Yes, Madam Chair, certainly we can do that.

CHMN. MAYES: Okay. When were those studies conducted?

MR. HOEKSTRA: Those studies have been conducted in the, since somewhere around the mid 2000, 2004 or 2005.

CHMN. MAYES: And has there been one done since then, Mr. Hoekstra?

MR. HOEKSTRA: I believe we are still negotiating and performing studies at our participant facility at San Juan.

CHMN. MAYES: Okay. Mr. Guldner, do you have -- obviously you are a participant in some of these plans that they were discussing, Four Corners being one of them. I take it you are a participant in that same study at Four Corners.

MR. GULDNER: Yes.

CHMN. MAYES: Okay. And, then, and you will commit to supplying any other studies of drought contingency on your other plants?

MR. GULDNER: Yes.

CHMN. MAYES: Okay. On the externality question.

MR. GULDNER: Chairman Mayes, I don't think we have strong objections if the Commission decides to put in the resource planning rules marginal versus, I guess, call it embedded cost. That's, ultimately the challenge is where, when you are doing resource planning, we need

to know what analysis to use so that we can propose the lowest cost or the best fit of the resource.

Our folks, in looking at the Utah study, I think we will have to develop the expertise to understand how to do a marginal cost, because it certainly, you know, you can look at what your current resources are, marginal cost means you have got a forecast of what the cost is under different assumptions. So we would have to develop, you know, some different internal skill sets to be able to do that. But ultimately we think that's why this workshop is important, so we can determine what inputs we use when we do that analysis.

CHMN. MAYES: Right. And so I guess the company so far has not done a marginal cost pricing analysis?

MR. GULDNER: I don't think in the resource planning -- again, as you heard with Mr. Lotts, you go through and you want to make sure before you propose as part of the siting process -- in fact, almost always water is a major issue, as you know, so companies are out acquiring water rights. And you typically know what the cost of the water is going to be at the time you are moving forward with construction of a power plant. And so I don't believe we have done, in the resource planning, a marginal cost forecast that we have used what we think is the internal cost of water.

CHMN. MAYES: And this may be a question, Mr. Guldner, for the next workshops, for the utilities to come back having done some homework, but what would be involved in conducting a marginal price costing, a marginal pricing of water as an externality, what inputs would go into that? What does APS and TEP and the other utilities believe ought to go into it?

MR. GULDNER: And I think that is it exactly. We would have to go back and look again. And I think we are looking at some of the studies and also other studies to see how this is being done other places.

Water is one of the easier ones, I will say, to probably tackle out of all the subject matter that is on the plate for externalities analysis. But, you know, we will certainly pull that together and hopefully come back and give you more detail on that.

CHMN. MAYES: Yes, Commissioner Newman.

COM. NEWMAN: Yes, to this point. To this point really, I have, I have been thinking about this now. That's one of the reasons why in my opening statements I said, you know, this is not going to happen overnight. It is going to take some time. And one of my ideas was, I don't know whether my colleagues will buy it or not, or it could help to have an outside party working with the Commission, you know, and perhaps even DWR or

whatever related agencies associated with air or water on some of these, but my idea was to have some, a third party, not necessarily the same third party that did the Utah study; although, I think that they are a good organization. I met the individuals and they similarly were interested in the project.

But it will help us. It will help not, sort of not doing apples and oranges, so we are on the same page sort of setting up the framework of what we can be talking about. And I think marginal pricing is part of that analysis.

And the only other matter would be trying to figure out to find a sum of money to do that study. And I don't think it is absurd -- I think it is reasonable expenditure. It is just a matter of trying to figure out if the Commission would be able to find that. I heard through the grapevine talking to folks that we could be able to get money to do such an important study.

And so I wanted to just put that into the record, that I am not, I don't think we need to put the total burden on the utility companies. We need to be working in tandem with some objective outside party.

CHMN. MAYES: Okay. Commissioner Pierce.

COM. PIERCE: Thank you, Madam Chair.

Mr. Guldner, I just had a comment as I think about the deal that you, that APS made with Phoenix. And that shows that the market itself is starting to take care of some of the issues that I have with the negative externality of this and how much water gets used. But some of these long-term agreements, I look at like some of the economic development agreements that are made with taxes and seeking to attract business to a community and using perhaps taxes or in some cases cheap water. And those concepts are a little bit shortsighted because you have to look at the long term of being able to have enough water for the communities to survive, at the same time having jobs, and so that balancing there.

And so just as in the -- I think food is undervalued for those, that's why there are a lot of subsidies out there, the real cost of food to us. We think, well, this ought to be this cheap, it has always been, but it doesn't even reflect what the cost of production really is. So I think the market is starting to take care of some of these issues.

But for me, I look at it because we see so much of it. A community may be looking at maybe one deal, but we see so much of it, if something really stands out that it is a bad deal. In my view, water is not being valued in this deal. To me it is just like some of the

other bad deals I have seen take place where perhaps a builder/developer or somebody gets a CC&N, comes to us, and this hasn't happened since I have been here, but in the past, water has been undervalued to help sell out a project or make, you know, to move homes faster. And it is not good for ratepayers down the road. It is not accurate. And it is just, to me it is just getting good information, getting it and having water place the value on the market and looking into the future. And that's, to me, that's at the crux of this.

MR. GULDNER: Chairman Mayes, Commissioner Pierce, I think that's right. I think that's the challenge with this. The marginal cost is, it is how do we tag that value, how do you determine what that value is. It is certainly easier to just go back to what your current contracts are and to look at that. So I think that's the additional skill set. You have to be able to do that marginal cost analysis. And it is not as clear-cut an answer but it is something.

COM. PIERCE: We may not have enough water to hang around to enjoy the electricity.

COM. NEWMAN: There are some people that believe it.

CHMN. MAYES: I think this is a really good discussion, Commissioner Pierce, a really good point.

And I am just looking at the marginal cost pricing section of the Utah report, Mr. Guldner. And it states, actually it is very similar to what Commissioner Pierce just said, and talks about, you know, the scarcity of water rights in the west. It says water rights in Utah are completely allocated, in some regions overallocated, meaning any party wishing to acquire new or additional water rights must find another party that is willing to sell them. Sounds very much like Arizona in a lot of ways.

COM. NEWMAN: Exactly.

CHMN. MAYES: But then it goes to describe how they did marginal cost pricing in this report. It says an estimate of the marginal cost in Utah was achieved through a survey of the database of water transactions in the 12 western states, maintained by the Bren School at the University of California, Santa Barbara. The source of these transactions is the monthly trade publication, Water Strategist, and its predecessor, Water Intelligence Monthly, published by Stratecon, Inc. in Claremont, California. So they did it in Utah, under a republican governor I will add, using this data.

Is it as complicated as you would seem to lay out? I mean maybe, I don't know, you know, and this is really a fundamental question, is it something that the

Commission can do in workshops or, as Commissioner Newman has suggested, is it something that has to be hired out to a consultant?

MR. GULDNER: Chairman Mayes, I don't necessarily think it has to be complex. I think you want to sort through some of the issues, like, in Arizona, what happens when you convert a, I can't remember my water rights stuff, but like a type 3 to a type 1. There are some different subtleties in Arizona water law. And as you move into effluent, that probably is looking primarily at just surface water rights. So we have got some nuances on it.

But from a standpoint of what inputs do you put into the resource planning study, that could be the way you go, just say you use the data from an accredited database, and that certainly makes it easier to do that analysis. It may then be a little different what actually happens when you go to secure the rights, but in terms of what you are looking for, if you are looking for relative to the rest the water rights in the state, don't really care what you get it for, if you get it cheaper that's great, but from a planning standpoint, we want to value it at what the marginal cost of water across the state is. I mean I think that makes sense.

CHMN. MAYES: Okay. All right. I want I know,

we are going to take a break here soon for lunch, but I do want to, before we do that, go to AEPCO real quickly and then throw it open to everybody to discuss some of these issues. Then I want to come back after lunch and continue to discuss them before we have the next presentation.

So speak into the microphone. If you can, state for the record, sir.

MR. ANDREW: Chairman Mayes, Commissioners, my name is Jim Andrew. I work for AEPCO as manager of regulatory affairs and planning.

Apache generating station is the only plant that AEPCO has. It is located in southeast Arizona in the middle of an agricultural area. The water source for Apache station is solely groundwater. There are three steam electric generators at the facility. Two of them are coal-fired base load units and one of them is a natural gas-fired steam peaking unit. They use wet cooling exclusively.

AEPCO does not have plans to build any new generation at this time, but should that come, should that come up in the future, dry cooling or hybrid cooling would be something that we would evaluate and consider at that point.

Right now I believe the plans are through the

Southwest Power Resource Group that is looking at our generation needs into the future, along with a number of other small entities such as irrigation districts and small municipalities. They are looking at taking power from a plant that already exists. So it is basically purchased power or operating at a power purchase agreement.

For AEPCO, no formal contingencies have been analyzed on extreme drought conditions. However, we recognize that we are in competition for available water sitting right in the middle of an agriculture area in Sulphur Springs Valley. From that perspective, we also recognize the increasing value of water conservation and water reuse, which we employ at this time. And we are always considering how we can make that better and reduce our reliance or the amount of groundwater that we have to use for Apache generating station.

In addition, we are looking at water treatment advances that can increase the cooling tower cycles, the amount of times you can put the same water through the cooling tower before you have to replace it with fresh water. And ultimately that will reduce our water requirements as well.

And the graph that you asked to be annotated is going to be real easy for us, yeah.

CHMN. MAYES: Okay. And thank you very much for coming up, by the way. I appreciate that.

Have you given any thought to the issue of pricing water as an externality and how that, how that should be done?

MR. ANDREW: I have not, but I made notes on it and I will certainly ask the appropriate people and come back with an answer.

CHMN. MAYES: That would be great. Thank you very much.

Okay. Any other questions of AEPCO? Great.

COM. NEWMAN: I just wanted to thank him for coming up as well.

CHMN. MAYES: Okay. Let's -- do we have the microphone? Nancy, could you take the microphone to the floor. And we will open it up for comments on the issues that have been raised by the Commissioners and the utilities and that are listed on our agenda, agenda items -- well, let's just say all of the agenda items listed. And that's, that's the microphone. Make sure it is on.

Basically the way we do it is anybody can start. Why don't we, why don't we -- well, let's just go ahead and, Mr. Schlegel, do you want to begin?

MR. SCHLEGEL: Sure, I will begin.

CHMN. MAYES: Okay.

MR. SCHLEGEL: Jeff Schlegel for SWEEP, Southwest Energy Efficiency Project. Thank you for being drafted -- I mean thank you for opening this opportunity for public comment and for addressing this issue.

As you know, water is a very important issue in our state. And I appreciate your focus on the water and energy nexus today. I am going to speak to the relationship between energy efficiency, energy use, and water use, quite a bit, a part of which you have covered this morning or other speakers covered this morning.

As you know, saving energy saves water, and vice versa, saving water saves energy. Saving energy reduces water use used to cool the generating plants, quite a bit of the discussion this morning. But saving water also at power plants and at customer facilities also saves energy by reducing the energy use for pumping and the distribution of water. That's a question I have been asking for years in Arizona, how much of the total energy that Arizona consumed is used for water distribution. And I have yet to get an answer. I am still looking for that answer, but I certainly would like to know. I think it is very important to attack these challenges, both the energy challenge and the

water challenge, from both sides, because, again, saving one saves the other and vice versa.

Energy efficiency analysis and cost effectiveness analysis of energy efficiency programs, to the extent that the cost of cooling water is included in the avoided costs of energy, with a proper price for energy, then the cost effectiveness analysis includes the reduced water use as an energy efficiency benefit, again to the extent that those things are true.

As part of our, SWEEP's, input and review of the 2010 energy efficiency implementation plans and the upcoming 2011 plans, SWEEP will check on this and report back to you. We are not sure it is being done properly, but we think the energy is included in the operating costs -- the water, excuse me -- the water savings are included in the operating costs, but we don't know if they are properly included or included in the types of pricing you are talking about today.

CHMN. MAYES: And, Mr. Schlegel, to this point, isn't that -- I mean that's sort of a big part of pricing, the need to price water as an externality properly, which is that gets plugged into our societal cost test. And if it is simply at the embedded costs, that's one thing. Obviously you are saving water, and I think we do measure that or we include that. But if it

were at the marginal cost, which is the cost of achieving the water at the next unit, which could be much, much higher than the embedded cost as I understand it, that would make those energy efficiency measures even more cost effective than they already are.

MR. SCHLEGEL: Madam Chairman, that's correct. And that was going to be my next point, but you just made it so I will skip over that.

CHMN. MAYES: Okay.

MR. SCHLEGEL: There is one thing about pricing water in the avoided costs. The price of energy is another thing, you know, how it is priced as -- how it is monetized as an externality.

In addition, the water savings for customers for things like clothes washers and spray valves, they are currently reported to the Commission only in gallons, not in dollars. So those water savings are not monetized at all, not the embedded or marginal price. And they are not included in the cost effectiveness analysis. And, therefore, the benefits for energy efficiencies are under reported in that way as well.

So we believe, SWEEP believes it is important to monetize water to accurately document the economic benefits of the energy efficiency programs in all the ways that we discussed today. There has been a lot of

discussion today about pricing water and about monetizing the price of water, the externality price of water.

I would submit to you that currently the price being used for customer water savings in your analyses is zero. That is the price; it is not like there is no price. The price that people are using is zero. And that by far is probably the worst price we could use. Water has some value but currently it is valued at zero for water savings associated with the programs.

CHMN. MAYES: Okay. So I was wrong actually.

MR. SCHLEGEL: That's from the customer savings. You were right for the operating costs associated with the power plants saving, but for the customer water savings that are a co-benefit with some of the energy efficiency programs, that's where the value is zero.

CHMN. MAYES: Okay.

MR. SCHLEGEL: And to conclude, SWEEP will review the documents on the record and may submit additional documents for your consideration relating to energy efficiency and water use and pricing water relating to energy efficiency programs.

So with that, thank you and happy to answer any questions.

CHMN. MAYES: Thank you.

MR. SCHLEGEL: Or pass microphone.

CHMN. MAYES: Commissioner Newman.

COM. NEWMAN: Yes, one question for Jeff.

Mr. Schlegel, Madam Chair, I know that we have a tendency to think that we could do the analysis within -- and I have sort of a behavioral scientist kind of background besides being a lawyer and I always think it is good to sort of have a third party look at stuff as well.

What do you think about the idea of doing a similar thing what Utah did to contextualize the discussion to create parameters of what we are looking at in each category, of having a third party, sort of objective entities being involved with that? And what are the chances of this Commission, if all five Commissioners agreed or if the majority agreed, what are the chances of getting funding for such a thing, for such a study?

MR. SCHLEGEL: Madam Chairman, Commissioner Newman, I appreciated the Utah study. I wish we had that study for Arizona. I think that was a good study. It was done by a reputable firm. I think it helped inform the discussions. I think independent studies like that can move the process along. It is possible for Arizona stakeholders to meet together and to develop

values ourselves. I think an independent review of values can contribute to that discussion and generally can accelerate the discussion. So I think it is a good idea.

The challenge -- second question is the challenge, the funding to do that. I think the benefit of an independent study is not only in its independence but it is also getting the work done. There is a lot of work going on in Arizona. I know your Staff are busy. The utilities are very busy on a number of different projects. And having somebody else put something on the table and take the first step, it, I think, would help. But as you yourself noted, funding for such a study can be a challenge. I am not sure, I haven't identified a funding source myself that could, you know, could do that.

I mean it depends how much of a priority it is for you and how broad a scope you want to do. There are measurement research and revaluation studies that look at benefits and co-benefits of the energy efficiency programs. And at least that component, I think, could be funded out of an independent study. The utilities could pool together their energy efficiency evaluation and research monies that are in all the budgets that you have approved and pool some of that money together and

fund a very, you know, specific study associated with the programs, or you may identify other sources, but I think that is a good thing.

But even in the absence of an independent study, what I have been saying about this issue for several years now is that let's at least get it started. A number of the different values that are used for water or carbon or, you know, NOx, those values, unless they are incorporated in the energy price explicitly, unless they are already incorporated, those values generally are zero. And we know that zero is the wrong value for all of those emissions and water use.

So I have proposed, you know, for example, one proposal I made was just for the environmental staff of the utility to get together in one meeting, propose a round of numbers and put those numbers on the table for all the stakeholders to consider. I think that could be done within a matter of weeks or matter of months, you know, if people really want to discuss it. I think what is most important is to get off of zero. Zero is the wrong number.

COM. NEWMAN: Thank you, Mr. Schlegel.

CHMN. MAYES: Well, I think that's very interesting. And I appreciate, Mr. Schlegel, you bringing that up. I agree zero is the wrong number. So

the question is what does the Commission want to do next and do we want to direct such a stakeholder process to begin.

But would any one else like to jump in here and provide comment?

(No response.)

CHMN. MAYES: Oh, come on, don't be shy.

COM. NEWMAN: Mr. Patterson?

CHMN. MAYES: A lot of shy folks in the audience today. Anyone else on the issue of externalities and water?

MS. MODESTO: I had a comment.

CHMN. MAYES: Sure.

MS. MODESTO: My comment is related --

CHMN. MAYES: Could you state your name.

MS. MODESTO: My name is Karen Modesto. My comment is regarding the use of groundwater for electricity generation and your comment regarding the GRD.

I know that with the GRD you are withdrawing water in one area and recharging it in another. However, you still have to demonstrate physical availability of those supplies. The 100-year supply usually relates to residential development. And a different type of groundwater withdrawal right is

required for a general use permit. That, of course, is only within the AMAs.

So it just needs to be kept in mind that physical availability of supply still has to be determined before you can just drill a well and start using the groundwater.

CHMN. MAYES: Sure. And I guess what I was concerned about was, you know, I have seen maps that have been done by DWR recently that show groundwater, the groundwater table being depleted, frankly, and groundwater levels declining significantly over the next 50 years. And for those water companies and electric companies operating in those areas, specifically the map I am thinking shows groundwater depletions all throughout the Phoenix AMA, it may very well lead to, as Commissioner Stump pointed out earlier or mentioned, referenced earlier, the need to drill deeper wells, potentially increase in costs of operating electric units or electric generating plants in those areas. That's all I was referring to.

MS. MODESTO: Right. I just wanted to make that point about the GRD. And also the --

THE REPORTER: Excuse me. I can't hear you very well.

MS. MODESTO: Can you hear me now?

The water supply is limited. And so usually when they look within an AMA for a groundwater supply, they have to show there is sufficient supply for that time of use, but it definitely has an impact on the supplies. But it is really how we are looking at it basically on the current rules for determining water supplies by the Department of Water Resources.

CHMN. MAYES: Right.

MS. MODESTO: Which also brings another point in mind, that currently Department of Water Resources is losing staff left and right and really can't evaluate the supplies like they should be, nor collect the data. So...

CHMN. MAYES: You know, I thank you for that. Was it Ms. --

MS. MODESTO: Modesto.

CHMN. MAYES: Modesto. Thank you very much for raising that point. And I was going to mention it earlier.

You made my point, which was I am terribly concerned about what is happening to the Department of Water Resources. They are, they have undergone significant cuts already, may undergo significant more cuts over the next year or so. And, frankly, I don't know what we are going to do. I mean it is utterly

unbelievable and devastating what is happening to DWR and, from my standpoint, appalling. This Arizonan is appalled by what has happened to DWR. And I think it places our entire state's water future in jeopardy quite frankly. And it puts even more pressure on the people sitting in this room, our utilities, this Commission, all of the stakeholders to fill in that knowledge gap, which is very hard to do. I mean so I appreciate your point. And I don't know what we can do about it except, you know, redouble our efforts in this regard.

Commissioner Newman, are you still on the board?

COM. NEWMAN: Just quickly. Thank you for your comments as well. And I just wanted to correct the record on one thing.

It is true about the AMAs and 100-year water supplies for 14 out of the 15 counties in Arizona. Cochise County is the only county that adopted the legislation and unanimously agreed that we have to be under a 100-year water supply. We were the only county to adopt on. Other counties could adopt on. But, so that is a unique thing not a lot of people know about.

And I just wanted to, in the stream, I want to hear public comment here, but in the stream of all public comments and response to Mr. Schlegel, to expand that and maybe challenge the utilities here right now.

This is a major resource planning area. And, you know, if we should go to a third party, you know, review, objective review, kind of setting up parameters, it would behoove the major utilities, you know, to think about using some of their resource planning dollars for this. It would be helpful, number one.

Number two, also the -- it is just intrinsically just a part of the resource planning. And this is going to go forward, so, or they can perhaps help us, help the Commission or even go out on their own communitively asking for another source from any one of the different groups that they belong to nationally, because this is a national issue as well. But we want to bring it home to Arizona.

So I am just challenging some of the utilities in the room to put on their thinking caps on how we might be able to finance this. There are a lot of smart people in this room and I think that we could figure it out, so environmental groups, industry groups, everyone. Thanks.

MS. ORMOND: I am Amanda Ormond with Interwest Energy Alliance. We represent solar.

And I think it is very interesting how much discussion has been around water use and solar. And we appreciate that. I am glad that this Commission is

actually looking at water use for all technologies, because from our industry standpoint, we have had a lot of discussion about just solar water use. And I think we need to have it much more broadly.

When we look at solar water use, the problem is we don't have a lot of plants to be able to look at and see what the water use is going to be. There are not very many reports that are out there that are really very good. So we are really looking forward to having plants in the ground where we can actually quantify what the water use is.

The other point I will try to make is solar technologies, with some of these technologies, we don't know what the ultimate water use will be because they are not mature technologies. When we look at water use of natural gas or coal or nuclear, these are very mature technologies. And we use less and less water over time. When we put the first solar plant in the ground, it is not going to have the most efficient water use because it is new. Over time, and as the utilities get better with these plants, then water use is going to go down.

So I caution a little bit looking at just those first numbers on water use of solar because they are going to be high because they are not mature. I think as we go forward and look at water use related to solar

and other technologies, especially solar, we have to look at plant by plant, where is the plant located. If it is on old agricultural land and water use is less like the Solana plant, that makes a lot of sense. But I also think we need to be looking at water in the resource planning context.

And I appreciate the Commission bringing together these workshops as well as APS coming forward and saying let's do some resource planning and put water and all these other externalities in that. So I appreciate the interest in this and will certainly be working to bring the best information we can.

CHMN. MAYES: Thank you, and thanks for those comments. And I think you are absolutely right, you know. I mean I think solar gets tagged with this water use issue and yet most forms of solar use next to no water, I mean one gallon per megawatt hour, relative to coal and nuclear, which are up in the 600s, or 5- to 600s.

MS. ORMOND: And wind, zero.

CHMN. MAYES: Wind, zero. So let's just keep that in mind.

And I would add, Amanda, as you know, many of the solar plants we have sited here at the Commission over the last year and a half have actually been sited

in the alternative, either CSP or PV. It is my personal view that a lot of those projects end up as PV. And all of them have been on former ag land, basically, or have ag rights, water rights associated with them.

MS. ORMOND: And let me just pick on my friend over here, Ginger Ritter, with Game & Fish. Game & Fish just came out with some solar guidelines recently and it states in there they are recommending dry cooling. And I think that we want to try to get to dry cooling for all our power plants but I caution adopting a widespread policy too early on because these technologies are new.

I think we need to get the utilities to get some of these plants in the ground, allow them to have time to work with them, become familiar with them, make sure they are producing good energy and have great capacity factors before we start clamping down saying everything needs to be dry cooling. That's why I made the comment about I think that things need to be looked at plant by plant. You are not going to want to put high water use plants in areas that are going to draw down groundwater or have an effect on rivers. And this Commission has a history of turning down at least one natural gas plant that I am aware of because of water issues.

So I guess I would advocate for let's walk before we run, let's start getting to know the

technologies before we try to adopt any kind of overarching policy that says either hybrid cooling or dry cooling, because you did hear this morning that there are significant penalties to going to hybrid cooling and dry cooling both in terms of how much energy you have to use of the plant and also how much footprint on land that you need to be able to do dry cooling for solar.

CHMN. MAYES: Well, that's an excellent point. And you would agree with me, Amanda, that that's basically how it is going to be done right now. It is, dry cooling and hybridized dry cooling is being normally vetted in the line siting process on a plant-by-plant, location-by-location basis.

MS. ORMOND: Correct.

CHMN. MAYES: Okay. And I know she hasn't volunteered to speak but I am fascinated about this new -- that Game & Fish is recommending dry cooling. Is that the Arizona Game & Fish Department? And is there a report that's available that you could provide to the Commission in this docket?

MS. RITTER: Well --

CHMN. MAYES: And state your name for the record.

MS. RITTER: Ginger Ritter, and I am with the

Arizona Game & Fish Department.

We have developed solar guidelines which are just basically recommendations of how we would like to see them developed. And so I could submit those. But we don't have a report where we have looked at dry cooling and wet cooling and hybridized cooling. We have just kind of looked at what is out there for how much water use. And taking that into consideration, the amount of water that's available in Arizona and wildlife habitats, that's why we are recommending more hybridized and dry cooling. We are not totally opposed to wet cooling but we don't approve of every plant being wet cooling when there is other options.

CHMN. MAYES: Thank you. Could you provide that to this docket?

MS. RITTER: Sure.

CHMN. MAYES: We can help you do that if you would like.

MS. RITTER: Okay.

CHMN. MAYES: Thank you very much.

All right. Anybody else like to take a crack at some of these issues? Mr. Moyes.

MR. MOYES: Thank you, Chairman Mayes, Commissioners. Jay Moyes with Moyes Sellers & Sims.

I would like just to reinforce a couple points

that Amanda has made and, first of all, commend the Commission for undertaking this study, investigation, workshop forum and anything else that will help illuminate the understanding and knowledge of the interface between electricity and water.

I have been working in this arena, as Commissioners well know, for a number of years. I showed up today because my truck license plate is H2OKWH. I thought this was something I just couldn't miss. So I am not speaking here on behalf of any particular client other than my own interest in the subject.

I have been involved in siting, I think, more of the new era of generation plants than anyone else, starting with Griffith and Sundance and NAAP and Coolidge, and then recently a couple of solar plants. And the message that I have gleaned from all of that with respect to the water issues, which the Chairman does correctly say are clearly and thoroughly vetted at the line Siting Committee level as well as here at the Commission level, some in greater degree than others depending on the situation, but that message is there is not a one size fits all answer to this question.

And I think the Committee has done an excellent job, as has this Commission, of looking at the facts of

each situation. And in those plants with which I have been associated, there has been a wide spectrum of both water factual situations from the siting standpoint as well as solutions and creative approaches to providing the water that's needed for the plants, Sundance using CAP water. In the case of Coolidge, we were fortunate in the location involving an irrigation district where we were able to recharge in advance essentially the total water requirement for the life of that projected plant. It is a peaker so it doesn't use a lot of water, simple gas turbines, doesn't have a steam cycle.

As Amanda alluded to, in the solar industry you have CSP plants that are steam turbine completely, therefore, compared to combined cycle gas plants, will use more water. At the other end of the spectrum you have photovoltaic plants, which will use minimal water for basically washing the panels. And I personally am inclined to agree with the Chairman's assessment of the likelihood that most of the plants that you have now approved end up being PV. As we saw in the case of the Agua Caliente plant out in Dateland, which it appears from my vantage point will be the first project to actually go in the ground in Arizona, and that's likely to happen very soon, farmland outside of an AMA, very productive agricultural economy input from that project,

but by putting the solar plant on part the White Wing Ranch, we were able to substantially reduce water use and yet shifted the melon operation, which was the most economically productive, to displace on the northern part of the ranch the citrus operation that wasn't very productive. It is a great win/win kind of combination that fell very well in the White Wing Ranch but wouldn't necessarily fit somewhere else, just like the advanced recharging of CAP water in Coolidge worked well there but wouldn't work at all in the Hualapai plant in Kingman. So each situation is different and unique.

Another point that I want to make, and Commissioner Newman sort of piqued my memory about this, we find ourselves sometimes caught between contradictory goals and objectives of different regulatory agencies. The worst example of that that I have encountered in connection with power plants was at the Sundance facility down in Pinal County, surrounded by farmland with not just gravel roads but a lot of those roads down there are just dirt roads, and yet heavily traveled by school buses and farm trucks and people living out there in times of the year. In that Coolidge, Casa Grande, Florence area, you know, the cloud dust is tremendous. And the PM-10 issues are very significant there.

When we were developing Sundance, we proposed to

EPA a trade-off. And some of you, I don't think any of the currently seated Commissioners were involved in that case, but what we were proposing to do was to, instead of installing about $40 million worth of selective catalytic reduction emissions control, which was a very small incremental addition to the basic emission control equipment and would have, and does now produce a very incremental and small additional NOx reduction over what the base system would have produced, we proposed to EPA to instead pave some $35 million worth of roads, which at the standards in that area would have paved 75 to 80 miles of road in the area of that plant. The PM-10 reduction, the emission trade-off is a no brainer in a situation like that, tremendous impact that would have had on the county, the cities, the county.

Everybody strongly supported it, but Region 9 EPA couldn't be persuaded that that was a sound trade-off that they could make. And as a result, we ended up spending the $40 million for SCR. We paved a few miles of roads just out of a good faith effort but it was all the plant could afford to do under the circumstances.

Those are the kinds of things that shouldn't happen. And I think to the extent that this Commission and other agencies can continue to study and evaluate

and get better data on the interrelationship between emissions, water use and other externalities and the true costs of generation, a similar situation exists in my opinion with regards to the true costs of solar and renewables when taking into account the firming requirement that those intermittent resources also necessitate on a part of the utility's planning.

I will end my comments at that point. I just congratulate and encourage the effort and remind that, again, one answer just, you know, dry cooling for all power plants, is too simple and it doesn't always work. It is not always the best answer.

CHMN. MAYES: Right. And I appreciate those comments, Mr. Moyes. And I think right now I agree with you. I am not sure forever I will agree with you. And that's why I wrote a letter to my colleagues suggesting that we look at this issue of at what point do we require at least hybridized dry cooling or dry cooling.

California, as you know, doesn't allow wet cooling anymore. I don't believe they do. It is very, very hard to do wet cooling projects in California. And, you know, I am not, you know, I tend not to -- I tend to believe that we ought to be flexible in some of these areas. But when it comes to water, I think that we are going to have to become increasingly rigid.

And so isn't there going to come a point where we say, sort of a cutoff date where we say, all right, yeah, Ms. Ormond pointed out we have had some experience with these plants, but, you know, enough is enough, and our water supplies are so precious, they are dwindling, we have evidence of that from DWR, so we have to go to at least hybridized dry cooling at a date certain?

MR. MOYES: I would concur with your general assessment of what the future ought to hold from the standpoint of water conservation. The only really counterpart but sort of additional point I would like to make, what I was glad I didn't hear was the word exporting our water in the form of electricity.

CHMN. MAYES: I was about to bring that.

COM. NEWMAN: I actually thought about it, Mr. Moyes.

CHMN. MAYES: We are going to hear it later today.

MR. MOYES: That has always bothered me. I have worked for 30 years for the agriculture industry in this state on water issues. As you saw on the diagram, the pie charts today, agriculture still uses the majority of the water in the state to the huge economic benefit of the state. And there is a whole lot of exporting that goes on in that in order for industry to continue to

survive.

The cost/benefit analysis, however, on water suggests in lots of places, and we are seeing this more and more, and I think the Commission and the Siting Committee have encouraged this, that the cost/benefit may be greater to use that water for generation or use that water for some other purpose as opposed to exporting it in the form of agricultural crops.

But, again, I do agree generally that water conservation is critical for the state as a general rule, and under all circumstances we need to be using it as efficiently as we can, whatever the industry.

CHMN. MAYES: Okay. Commissioner Pierce.

COM. PIERCE: Sure, and I appreciate it, Mr. Moyes. But, and I recognize that whether it is manufacturing, whatever we are manufacturing, that, and I think part of the balancing is how many jobs does that affect. And so I think it is all part of that, the externalities of each of these things.

But I think what is really going to happen, that will happen relatively quickly for me, is there are certain regions of the state, and I agree with Amanda, probably one size policy doesn't fit, because we have different regions of the state that have a little more water than other regions. And I would expect that if

someone wanted to put a power plant in and it really wasn't advantageous to the region with employment, that I would hope that the fathers of that community would take a good look at that and really make a call on what was important for them to have in desiring to build an exporting generation plant and that's not something that's for their own use.

So I think we are going to -- I mean I already, I won't get into cases, but I am already thinking about the areas that work and don't work. And just like Dateland, having lived in that area, I know darn well there is a lot of citrus that ought to not be there based on the water that is consumed for the jobs and production that's there, that there are better places for citrus. And so there is some very obvious places to put some of these facilities, solar facilities and other facilities with access to transmission lines. I mean it is, there are some really good places in this state. And for me, that's a lot of it. I can see it. I can recognize it. And I am already placing a value on it.

MR. MOYES: I agree. And I hope my comments were not misinterpreted to think I am upset about generation that may be exported. I think it is a question of highest and best use. In certain circumstances a generation plant may be the highest and

best use of that water in that locale. And, again, always with the water issues, it is not so much that we don't have enough, we just don't usually have enough in, quite enough in the right places.

CHMN. MAYES: We are going to have to take a break now. Come back around 1:30.

(A recess ensued from 12:39 p.m. to 1:45 p.m.)

CHMN. MAYES: Let's go ahead and get started, if we could. We have a very special, I think, presentation up next, a special guest here at the Commission. And I know that all the Commissioners really appreciate Mike Pasqualetti for coming down to talk to us. Mike is a professor at the ASU School of Geographical Sciences. He is also a professor at the Barrett Honors College at ASU and teaches at ASU Policy Technic as well.

But what I know him for and what he is increasingly known for is the fact that I think he is the only person in the State of Arizona who has really taken a good look at the water-energy nexus, especially as it affects or as it -- the side of the equation that involves energy, the energy-water nexus. And he has got a great presentation. He has studied the energy-water nexus and has taken a very close look at the exportation issue associated with water use and energy that is both used in Arizona and exported.

So without further ado, Mike Pasqualetti, if you could, come and just say a few words.

MR. PASQUALETTI: Thank you, Madam Chair and members of the Commission. I am speaking with you today about energy and water. And I must say that I am speaking for myself, not ASU or my wife or anyone else.

I do want to say that I am very delighted that you are going to be talking about energy and energy externalities because this is something that I have long thought was a neglected topic, especially when comparing energy resources and calculating their true costs. And today I am going to address the matter of water and energy as a part of that externality discussion. But I must say that it is a very large topic and we are going to be talking about just one part of it. There are many other parts to it.

I am going to be talking about the water costs of generating electricity. You can also be, of course, speaking about the energy costs of providing water. And even within those two broad topics, there are several subdivisions. And one is how we better use water within our cities to curb the urban heat island. And Professor Ruddell is to my left behind me who, if there is time, has comments about how you can reduce energy using water to lower the urban heat island. But my specific topic

today is going to be the embedded costs of power and what it suggests for the energy trade and power plant technology, and renewable energy, which is something I am quite interested in.

I am on the board of the Arizona Solar Center. I used to be the chair of the Arizona Solar Energy Advisory Council appointed by governor Napolitano.

Well, this is a picture here -- I am going to be directing your attention to the slides. And we have several photographs here. One of them on the left is the Navajo generating station. And the stacks on that, the chimneys are almost 175 feet tall, meaning that plume coming off the cooling tower is several thousand feet tall. It uses a substantial amount of water, of course, coming from Lake Powell.

And in the top center part is the Cholla power plant, another coal burning power plant, that has a lake dedicated to it to pump water out into a lake, and then the Navajo generating station again on the bottom here with Lake Powell in the foreground with the station in the back, and then the Palo Verde nuclear generating station here which uses water here as well from the 91st First Avenue treatment facility. So I am going to be going through these. Please feel free to interrupt me any time, ask for clarification or more detail to the

extent I can provide that.

And I will simply point out that Nobel laureate Richard Smalley has identified these two concerns as in the top ten for the next 50 years, water and energy. And it is interesting that we have been talking about energy and water but only in the last few years have we been talking about water and energy together. So I wanted to change that discussion a little bit and get some emphasis on both of them together.

So they do tie together. It takes water to make electricity and all kinds of other parts of the energy cycle, not just electricity. And it takes energy to produce water. Something like 20 percent, 25 percent or more of energy in California is used, the electricity is used just to move water around. And we use a substantial amount of water here in water to move water around. But I am not going to be talking about that. I am going to be talking about the water costs of energy.

But one of the things I wanted to emphasize here was that in terms of the water withdrawn, irrigation and thermoelectric, power plants are now responsible for approximately the same percentage of water withdrawn -- it is not the same thing as saying water consumed but it is water withdrawn -- so that we are now on parity. In fact, since this was prepared, I believe that

thermoelectric now exceeds irrigation in this country, again, water withdrawn, not necessarily evaporated. But it shows you the trend is going to be more and more that power plants use more water than any other -- require dedication of any water than any other use in the country.

Just to list these people, many people helped to put the data together. It was supported by the Arizona Water Institute, particularly Scott Kelly, the first one named there. He was my research assistant at the time and has gone off to better things than working as a teaching assistance, research assistant for me. But he actually did his master's thesis on water and energy nexus for the entire Colorado River watershed, which is another interesting study. My study is just the State of Arizona.

Now, when I talk about water in Arizona, we have this kind of tourist impression of Arizona, the tallest fountain in the world, several golf courses that you probably have seen, water everywhere. So I was thinking how can we kind of humorously look at the two things Arizona might be known for, probably water use and the military opportunities that we have in this state. And here is what I have come up. This is jet waterskiing; it is a famous water activity in Arizona. That was just

to emphasize the sense that a lot people think we are not really in the desert that we are in. In fact, we are.

So I am going to talk about these six topics. And when we get to the end of this, we will talk about some policy implications, at least from my view. It will be up to you, of course, to decide whether they are useful policies. But I want to talk about population growth and electrical generation consumption; a bit about the cooling water by source, where it is coming from; the water consumption by fuel, that is each fuel uses different amounts of water; and then the transfer of water in and out of Arizona; and the last, policy recommendations.

So let's first look at the population growth. Here is a diagram which shows the anticipated growth rate in Arizona, the speed and location of it, at any rate, over the years. Everybody knows that Phoenix and Tucson are growing, almost going to mesh sooner or later so that Commissioner Newman, in fact, will have his commute reduced as these cities merge here.

COM. NEWMAN: Hopefully with rail.

MR. PASQUALETTI: The population and the energy demand go up in lockstep to one another. These are data that are provided by a variety of the energy companies

around. But the blue line is population and the columns are megawatt hours consumed. So we are, in fact, increasing our energy consumption and we increase it as the population goes up.

And APS, and there are a variety of even newer numbers on this, but there is an anticipated substantial increase need for both APS, SRP, TEP and the cooperatives. All of them anticipate that they are going to need a substantial increase in the generated capacity. All of that increase, minus some of the renewables, are going to require additional water supplies.

Right now the water is supplied half by groundwater and half from the Gila and Colorado River supplies. And that's it, especially if you are talking about Phoenix. Phoenix is actually a pretty well watered place for being in a desert. Tucson is another story. But we have water that we are pumping, that of course takes energy, and water that we are pumping out of the Colorado River in the neighborhood of 3,000 to 3,500 kilowatt hours per acre foot down to Tucson. So it is not an insignificant amount of electricity that we are using just to pump the water around the state.

But I want to point out that there has been some reduction in the water use. This is from 1980 to 2000.

There has been some reduction in water use. And that is even with the population increase. Now, the reason for that in part, or two reasons, one is that we are transferring water from our agriculture to a municipal use and our industrial use. This is one way we can get more water. We can transfer it from the uses that we now have.

CHMN. MAYES: Dr. Pasqualetti, but going back to the slide before this one, 13, was that all water uses, Arizona, all water uses in Arizona, or just electric? Is that both electric and other purposes?

MR. PASQUALETTI: As I understand, the total amount of water used, not just for electricity.

CHMN. MAYES: Okay, got it.

MR. PASQUALETTI: Now, what is happening, the population is going up but per capita use of water is going down. This is a good sign obviously people paying attention. We are using water more effectively, we are using drip irrigation sometimes, we are curtailing needless use of water, taking our turf out and putting in desert landscape. We are doing a variety of things. So the trend per capita is good. But, in fact, we have, we just have more per capita so more people who are requiring that water.

So the water situation is that we have got a

certain amount of water. We are not going to make any more water from the existing sources. I mean there are sources beneath us that are rather briny that we could perhaps use in some ways, but for all intents and purposes, the way we are going to get more water is we are going to have to use it more effectively and more efficiently, not that we are going to get more absolute amounts of water.

So let's look at the electrical generation and consumption here. Arizona power plants, you all know, certainly on the Commission know, where these power plants are. Coal power plants tend to be on the peripheries, partly because the coal is there and partly because the air pollution requirements of combusting coal. Navajo generating station is in fact the only generating station in the state that actually uses energy fuel from the state, if you think about. All these other sources use energy from someplace else.

And then, so we are getting electricity from the Navajo generating station, which of course is way up here near Page and the San Juan and Four Corners, and farther up into Colorado, the Craig and Hayden plants. And then there are a variety of other coal burning plants. That's the black symbol here. There is a lot of closer plants. And these closer plants are mostly

natural gas plants and usually combined cycle plants because of their efficiency. This is a very nice technical move, that is that these combined cycle plants, being more efficient, use less water per megawatt hour. And several of those have been constructed now, the Panda plant near Gila Bend, certainly the Kyrene retrofitted, and many others. So this is actually a good move from a technical standpoint and water standpoint.

But we still have this import and export of electricity. This is where it gets kind of interesting for people. They are saying why do we import and export, why don't we generate all we need. Well, there is a lot of parts to that question. And it has to do with where do you get the energy, what is the cost, what does it cost to export, what does it cost to import. By the time you look at it all, we are importing a certain amount of our electricity. We use about 75 million megawatt hours a year, and we produce that in state, about 84 percent of it in state. We get the rest of it from Colorado. We get it from New Mexico, some from California, but mostly that import electricity comes from New Mexico.

CHMN. MAYES: Commissioner Newman.

COM. NEWMAN: I really didn't want to break in,

because I know this is -- you have a lot to teach us. But on this import/export question --

MR. PASQUALETTI: Yes.

COM. NEWMAN: -- it is complex. And I think some of your studies are the first time I learned about that dynamic of import and export.

And do you have a monetization of that import and export, or do you just have percentages?

MR. PASQUALETTI: Chairman Mayes, Commissioner Newman, I don't really have a monetization. And there are people in this audience who probably can address that question. I don't know exactly how much it is. You can kind of make a rough estimate.

COM. NEWMAN: And I made rough estimates and I am just not sure whether they are accurate or not. But it is very telling when you tell the story to laypeople out there that we have the largest nuclear power station in the country and that we do make our own power but we are on sort of a negative trade deficit, if you would, on the amount of money that goes out as goes in. And I just wondered whether that has any relevance toward this monetization of externality discussion.

MR. PASQUALETTI: The externalities, I can't tell you the specifics about the cost; although, we can certainly make back of the envelope calculations, and

certainly utility companies can answer that more specifically than I can, because I am really focusing more on the water.

COM. NEWMAN: Okay. Thank you.

MR. PASQUALETTI: Sure. Thank you.

So we are importing but we are also exporting. And, again, we export for a variety of reasons. We have contractual obligations to export. A lot of it goes to California from Palo Verde, and Texas from Palo Verde, and other states. So we are exporting -- we are producing 105 million megawatt hours and we are exporting maybe 29 percent of that to other states. Again, these are, these are exports and imports that are a result of the financial conditions and the availability and the transmission requirements and the availability of transmission capacity to move it back and forth. So it is a very interesting and complex topic.

But when we do that, as we are going to see, we are importing and exporting water as well. So here is where the electricity goes. This is just an average for five years. But California gets more than any other state, several other states get it as well, and that California is a very big market. And a lot of reasons why California needs that electricity, why they are

getting it from Arizona, is the higher price of that electricity in California, variety of other reasons that they use that.

Now, what the net is then is this, minus about 16 million megawatt hours, so import about 31 million, we are expecting about 14 or 15 million, so the net is we are exporting about 16 million. Now, when we are doing that export of electricity, we are exporting water, too. And we will get to that in just a second.

So, first, cooling water by source, this rather complex table, which I will make more clear in a second, simply illustrates the four sources that we have for water: groundwater in the first column; surface water for non-hydro in the second; surface water, hydro, in the third; effluent and the reclaimed water in the fourth. And the colors there, the orange color means natural gas and the blue is hydro and the gray is coal.

But if you look at this, what you find is that we get more water for electricity manufacture or power generation, we get more water from groundwater than we get from any other source. So we are taking groundwater. In fact, some of the power plants, like the Coronado power plant and Springerville power plant, were largely put there because there was a great water source there. There is a lot of water in their aquifer.

But we are getting more of our water from groundwater than any other source.

So what is the water consumption by fuel? Here is what is interesting, that coal uses more than half the water. So we are generating electricity and more than half of that electricity is being produced from coal, and that is the water, rather, is going to power plants more than any other source. So that 62 million in this case acre feet -- 62,000 acre feet of water in this case, coal is responsible for that use.

Now, this is, this table requires a little bit of attention. And I will walk you through it from the left to right. This represents the gallons per megawatt hour of power produced. Nuclear uses the most, about 785 gallons per megawatt hours. These were numbers that were gleaned from data provided by the utility companies verified with data from the U.S. Energy Information Administration and with the FERC, and then again checked with the individual power plants. So we are pretty confident about the numbers themselves.

So nuclear uses the most because nuclear has the lowest thermal efficiency of these power plants, operating somewhere around 32 or 33 percent efficiency. Then when you get to coal, it uses less water per megawatt but still 510 gallons per megawatt hour, and

then natural gas even less. Then there is a little landfill; a little biofuel; we will get to solar thermal in a minute; and then natural gas combined cycle even less, which is one of the good reasons that combined cycle is so effective around here; and geothermal, at least the power plant that was operating when we did the study, not very much; and solar PV much less than one gallon per megawatt hour.

COM. PIERCE: Are these all Arizona figures?

MR. PASQUALETTI: They are all Arizona figures, just Arizona, just the power plants that supply Arizona.

COM. PIERCE: Thank you.

MR. PASQUALETTI: Now, the numbers that are the most interesting I think are, and here is solar thermal, because this is getting a lot of attention, we took the numbers provided to us and checked them with APS for the facility, the one megawatt facility near at the Saguaro power plant near Tucson. This is a rather unusual power plant because of the engineering involved. So what we did is, because it was just one megawatt, one example -- we did two things -- we first looked at the engineering assessment for the Solana power plant which has been proposed near Gila Bend and we looked at the Kramer Junction concentrated solar power facilities in California. And they average out around 900 gallons per

megawatt hour. And this means that the solar thermal is using more than any other source, which is an interesting finding. And we are going to talk more about that in a few minutes.

Here is the embedded water transfers. Now, I talk about this as embedded water. Sometimes people talk about it as virtual water. Now, it is useful to give a little background here. If you grow cotton in Arizona and you export out of the state, you are exporting water in the cotton, the same thing with alfalfa. But you are also doing it with energy. So if you are making electricity, you are condensing -- you are cooling your condenser with water. You are going to be using that water to make electricity. So in a real sense you are sending that water around embodied in the electricity as virtual water. So I want to talk about that a little bit.

So here again, to review, we are bringing in a certain amount of energy from out of state and we are exporting a certain amount of energy to other states. And when you do the numbers here, and to do these numbers what you have to know is how much water is used to generate each megawatt hour of electricity and what is the percentage of that megawatt hour that comes from each of the fuels, so the nuclear is more and coal is

less and combined cycle is less, so if you do all of those calculations, what you find is that, in rough numbers, about 30,000 acre feet of water is exported from Arizona. That is, 30,000 acre feet of water is the net amount. We import some in our electricity, we export some in our electricity, but the net is that we are sending, about 30,000 acre feet out.

COM. NEWMAN: Madam Chair.

CHMN. MAYES: Commissioner Newman.

COM. NEWMAN: I asked a former hydrologist this morning about how much that is. I know that's a number. Can you give me a physical application of that?

MR. PASQUALETTI: Sure, Madam Chair, Commissioner Newman. There are a variety of numbers floating around. Sometimes people say one acre foot per household. You could probably do better. You could probably do half an acre foot per household. If each has a couple people in it, we are talking more or less the population of Tempe in terms of the water that we are exporting.

COM. NEWMAN: Thank you.

CHMN. MAYES: So, Professor, so our net water consumption, is it the inverse of that, so we are actually exporting 29,000 acre feet? It is a more complicated explanation than that, but I do notice very

different figures for California and New Mexico. As for Arizona it would appear that we are by far the most, to put a positive spin on it, neighborly state in the region in terms of providing power to our neighbors.

MR. PASQUALETTI: Well, Madam Chair, yes, indeed. But you can see the numbers. Plus we are sending it a little bit to Colorado. We are sending a little, we are sending some to New Mexico. We are sending some to Texas and some to California. So, yes, we are doing, we are sending -- well, we are sending most of our electricity, of the exported electricity, to California. So, therefore, we are sending most of the water to California as well.

Now, here is the part which becomes kind of interesting, and it gets us into discussion of renewable energy, which is part and parcel of all this I think anyway. Just to give you some idea, there are cooling technologies around, dry cooling technologies. These data are taken from the Silverhawk power plant that was partly owned by APS one time, no longer, but nevertheless provides you some data. And indeed this is a power plant that is a thermal electric power plant that requires water. Over here, the normalized water consumption in gallons per megawatt is 17 or 16. Remember that the ones for nuclear were 785 or so and

coal was 510. So this is well over a magnitude less water if you use dry cooling.

In other words, there are technologies for doing this. You can put dry cooling technologies on the existing power plants. But you have two penalties for that. One, it costs you more to build these power plants. And, two, the power plant efficiency is somewhat reduced. So you do pay two penalties, and eventually that ends up in being paid for by somebody.

This, to give you a sense of dry cooling cost increments, here is once through in terms of capital costs. And you can just look at, rather than the numbers on the vertical axis, here you just see that once through, which is a cooling technology that Cholla power plant and Four Corners power plant uses, and wet cooling system, which would be used by a variety of other power plants including Palo Verde, and then the dry cooling system. And, you know, you can see the capital cost substantially higher. So you will have to pay more for these power plants and there will be a reduction in the efficiency of the operation of the power plant as well.

So here is another what I find an interesting topic. And that is the merchant plants and unregulated plants. These plants, a lot of them have been moved

into Arizona recently. And they move into Arizona, they use the water from Arizona, but they oftentimes export their electricity to another state, primarily California, in part because California's rates are higher.

So do merchant plants provide enough of a return to compensate for the water they use and export it? This is a question I have asked, is that an adequate compensation, are they being, are they being requested or forced in one way or another to compensate for loss of water. Because you are taking water out of the ground in most cases here. You are passing through your condensers. You are evaporating that water. Electricity is effectively sending it out of state. So I don't know where that comes down, but I am just raising that as a point for some discussion.

Importing electricity, if in fact this becomes a problem, perhaps we should emphasize places where water supply is not so critical. That is, put your power plants where the water is in abundance. And this presupposes, of course, that you have the transmission capacity to bring it in. This is a big if, of course, but this has actually been an idea that has been bandied about in the Western Governors Association and many other bodies, maybe we should be putting our power

plants farther away and bringing in the electricity and using water that's more abundant in those places. But, as they say, transmission is the key.

This gets us to renewable energy. And the question that I would like to ask is how might the value of saved water provide extra incentives in support of developing renewable energy, including at the border with Mexico. In addition to the study that I am reporting on here from the Arizona Water Institute, there was a second study, where we looked at the water and energy nexus at the U.S. Mexico border. And some very interesting results came out of that study, some of which I will talk about here.

So wind power, geothermal power and solar from left to right there. You have seen this 100 times. We are the best state in terms of solar. There are places in the United States like Death Valley and places in Mohave that have more solar installation but none that, as a state, have more per meter or square mile than Arizona.

Yet in many ways we are the doughnut hole in the solar scheme of things with surrounding states having a lot more solar in many cases than we do, and many places, such as New Jersey, having perhaps more than Arizona, and cities like San Francisco having more than

Phoenix, which is an oddity to say the least. Having grown up in San Francisco where I never saw the sun for two or three months at a time, I can tell you that's an oddity.

Now, we have actually taken some steps. We have, for example, put a concentrated solar power facility at a correctional facility, or politely called a correctional facility, a prison, in northwest Phoenix. And the goal that we should have is to get solar to be used by people who are not incarcerated, by people in fact like most of us. So that's the goal. And we have been making a little progress.

This is one that looks similar. This is the one at Saguaro, just a megawatt in size. I took my students down there not long ago, very, very interesting. We talked about such things as how much they get out. It is an experiment facility, not meant to do a lot of things that a commercial facility would do. But they do wash these panels, they do wash them.

And then there is some, a proposal, of course, to build the Solana generating station west here of Gila Bend on land which I understand is either cotton or alfalfa, which, just for numbers' sake, alfalfa uses about six and a half acre feet of water per year and cotton uses about four and a half acre feet of water.

And I will get to why that is important in a second. So Solana is just one of dozens of proposed power plants, solar plants in Arizona.

This is the type of power plant that would use somewhere around 900 gallons per megawatt hour to generate electricity.

And this is Kramer Junction there. Actually, of course, they have machines and they wash these mirrors. Clearly the mirrors get dusty and oftentimes they have to use deionized water. So that's a little bit more of an expense. And then it looks like they have a machine here, but as I will show you in a second it is not always a machine.

But let me point out here is dry cooling for solar. You don't have to have, you know, the water use for cooling. You can use dry cooling here. And then you get down to 43 gallons a megawatt hour, again an order magnitude less than other sources. Now it is not 900 gallons, it is 43 gallons. Now we are talking something that's quite reasonable. And there are dry cooling technologies around that can be used for solar. But, again, you are going to pay a penalty in efficiency and in cost.

This is provided by SES, but the idea is that all solar is not the same when it comes to water. So

there is a lot of discussion and I have heard it on television and NPR. I have listened to various elected officials in this state talking about how much water solar takes. But not all solar takes the same amount of water. And SES has put this together, and they say it will take somewhere in the neighborhood of 22 acre feet a year for a 500 megawatt plant. Well, I will give you the real numbers in a second.

Air cooled power tower, air cooled geothermal, air cooled coal fire, so forth and so on. Here is water cooled parabolic trough, that's the kind at Saguaro. This is of course SES's diagram and I cannot tell you that I know if this is absolutely accurate, but I offer that as some example, as an exhibit here.

There are some types of solar power facilities that do not use water. And here is the largest in the state, around a five megawatt facility around Springerville power plant. This is constructed on land owned by Tucson Electric Power. And it is a very large array. Looking at it on the ground it looks like this. And they are doing it for a variety of reasons.

They have a variety of panels in here. They have thin film. They have all kinds of different panels in here. They are all monitored. They are testing. It is a very large array. It is one of the largest arrays

in the world. And it goes on and on. And people come out here and they trim the weeds, which are the real problem, in between.

And some people would say you don't ever have to use water. I have asked several people I know who have facilities like this, people who have 30, 40 years experience with photovoltaic. They say they never wash their photovoltaics ever. I have got them on my roof. I have never washed them ever. Maybe occasionally, if it hasn't rained for a couple months, I wash them, just spray them off, but maybe twice to three times a year.

And we have also moved forward in terms of ASU. We have got two megawatts now solar out there. These are tracking, single axis tracking on the top of parking structures. They are going to hopefully install, I heard this morning, up to eight more in phase two and another three after that in phase three.

And, of course, you can put solar on your roof. This is, as in an area where you have got homeowners associations, they won't allow you to tilt them sometimes, so this is flat. It is not the optimum, of course. On another house, we can see them on the roof. Here they are tilted to about 20 degrees. And this particular house they provide, this is 4.3 kilowatts, it provides 40 percent of the electricity of that house.

It is absolutely silent. It is seamless. It takes absolutely no water.

Now, I was invited to go out to Maricopa Solar the other day. It is in Peoria, 75th and Northern, next to the Agua Fria plant. And this is the SES SunCatcher system, Stirling Systems. And this is what they look like. Some of you perhaps have been out there.

Now, ostensibly these use very, very little water. They don't use water in the cycle itself because they are operating a Stirling engine. And they concentrate the sun's energy on that Stirling engine. The pistons go up and down and generate electricity. It is a nice system. It has taken them a long time to get this launched but they have had some nice investments recently and they are breaking ground on the first phase of an 800 megawatt facility west of El Centro, again an area that doesn't have a lot of water, in Imperial County.

Now, they do have to wash them. Here is the -- they have kind of a cherry picker. You can see the people up there on the side washing them. This is their greatest O&M expense there, is washing these mirrors. And they have to use deionized water, again, so they don't get any deposits on the mirrors themselves.

And just to give you a sense, here is the dirty

one on the left and cleaner one on the right. It does diminish enough so it is cost effective for them to go out and wash them. It does diminish their productivity. Now, that's a small facility, a megawatt and a half out there.

But if we look at -- here is I think, here is what the SES, or Sierra, which is the company that's doing the development, has in the pipeline here. Here is the Imperial Valley one, they say about 750. Here is one near Calico Hills to the east of Borosolvay, 850. Here is the one and a half megawatt, the one out in Maricopa. They are putting 850 down in Texas.

So one of their sales points is they don't need water. You can argue about all sorts of other parts of that.

Here are power plants that have been discussed to be put in coming up in the near future, one to the east of Tucson, others near Silver City in New Mexico, others up in Colorado. So there is a variety of them. In other words, they have finally got themselves launched.

When I was chair of the Arizona Solar Advisory Council, I had two members on that council, one member on that council from the SES, and they were not going anywhere but now they are. And water is one of the

issues that they have taken into consideration as they are moving forward.

Another, and people in the room here can talk about this, if you would like to ask them, but EnviroMission, I have talked with these people quite a lot. We put proposals in to them to do work for them out at ASU. This is the solar towers we publicized in the Arizona Republic. This is a tall tower of thousands of feet. But the idea is that you would get a natural movement upward of hot air and that would create a low pressure in the middle here and pull in or induce in air from the sides of this brass mile-wide array of translucent, transparent surface material. And that, with that air, as it passes by these turbines, would turn the turbines and generate electricity. It is kind of like the greenhouse effect with a chimney on it.

Now, this also doesn't use any water. Again, it is something that EnviroMission has used to discuss where they, where they can put them and where they are, where they can get any water that they need. But they are not going to need much of any water to do it. There may be other obstacles here but it is not going to be water.

Now, just to take you into Mexico a little bit, the solar map that I showed you for the United States

just extends into Mexico. Clearly the border doesn't stop the sun. The amount of energy there in northwestern Mexico and Baja and in Sonora, Sinaloa, neighboring states is substantial. And Mexico is a bit farther ahead of us in some ways in the way that they want to combine water and energy there.

One of the ways that they are considering doing it is using a variety of solar techniques to desalination facilities. There are many says to desalt water. Not all of them are going to be appropriate for solar. But one of the ways you can do it is make electricity and do a reverse osmosis. But there are other ways, too.

But you also don't have to take that water from nonpotable up to potable. You can take it from brine up to agricultural standard, for example, and then release some of the water that you are reusing for agriculture to the municipalities. So you can do that. Mexico, and particularly the University of Mexico, UNAM in Mexico City where I was visiting last June, they are pretty far along on this. And they have some technologies that can do this.

This is something presumably we should be looking at even more. And I certainly talk to people in the state, state agencies about this, and that has

gotten some attention. And there are a variety of ways to do this.

There are other ways, I might add, and I don't have here on slides, that use algae both to sequester carbon, which is one way to do it, and also to produce energy without the use of any kind of water, even if it is brine water.

CHMN. MAYES: Professor Pasqualetti, Commissioner Stump raised this issue earlier today. And I was, I appreciate him raising it and you talking about it. So is it being explored anywhere besides Mexico, for instance, in California? And then I guess it would be interesting to hear from the utilities later on what they know about the technology.

MR. PASQUALETTI: Madam Chair, yes, it is being explored in many places. Certainly the Middle East is exploring it. Substantially, I think all the utilities are well aware of the potential here. It is usually a cost problem. California is certainly looking at this. California Energy Commission has looked at this in some substantial detail.

Again the interest would be close to the border, Imperial County, perhaps Riverside County in California. So these are possibilities. And part of it has to do with what is the present cost of water, what is the

present cost of energy.

One of the reasons that people say that we haven't moved faster on solar here is because your conventional energy sources are fairly inexpensive, especially compared to California. That is the reason they sell in California. So there are possibilities in a variety of states. That is certainly something that everybody is looking at. There are journal articles about this, quite a number of them in fact, that can give you substantial amount of detail. And I am sure somebody here in the audience can talk about that as well.

CHMN. MAYES: Commissioner Stump.

COM. STUMP: Thanks, Madam Chair.

Just to that point, Professor, I guess part of the problem, which I think you sort of hinted at, is that according to a Pacific Institute study that I was looking at earlier, the energy use accounts for about one third to one half of the cost of the produced water. And so the supply is thereby vulnerable to changing electricity prices. And the Pacific Institute, at least in their opinion, they felt that including the cost of producing the desalinated water is unlikely to drop, at least in the short term, below about $980 per acre feet. I would be curious to know if you agree with their

assessment in those two respects.

MR. PASQUALETTI: Madam Chair, Commissioner Stump, I have seen those numbers. And I have also seen numbers that are at least an order of magnitude less than that. So I would suggest that that might be something to look into in more depth. I know that Peter Gleick at that institute certainly has discussed this sort of cost range.

But it is less than that. I mean I can tell you from my own research, and I am not an expert in this so I can just tell you what I have read, it is on an order of magnitude less than that. So you can -- there are articles. We can find them for you if you are --

COM. STUMP: Thanks.

CHMN. MAYES: Commissioner Newman.

COM. NEWMAN: To this point as well, and I would like to hear from anyone in the room that may know more, it is really interesting how you said that, you know, these are all matters of cost/benefit. You know, we have, we probably have the knowledge to do it. And it is about numbers.

But the question is if climate change changes North American climate and, you know, we may have to be doing this kind of thing lickity split, and not necessarily on the coast because the coast can be

inundated with water as well, so it maybe puts Arizona in a unique position to be a leader in this sense. And certainly I think somebody should be looking at it. And I am not talking about ten years from now, but certainly within the next, you know, several decades.

What is your comment on that?

MR. PASQUALETTI: Chairman Mayes, Commissioner Newman, I have talked with people at DWR here in the state certainly. They are certainly aware of this. They think it is a possibility. There are people researching it, talking about it.

I went down recently with some people to the desalination facilities near Yuma. That is -- they are starting that up again. There is a lot of, there is a lot of possible ways to do this. For example, if you, if you -- well, we can do it here. We can desalt here in Arizona, or you can go to San Diego for example and they can have desalting facilities along the coast.

COM. NEWMAN: I think they are looking at it, from what I understand.

MR. PASQUALETTI: I think they are. And that releases water back up the Colorado River which we can then tap. So there are ways we can do it directly or indirectly. But clearly there are pools of briny water in many of the basins in Arizona that could be utilized

for the purposes of desalination.

The use of algae, for example, algae can be grown in salty water. You can produce fuel out of it. It is a substantial other area that we didn't look at in the study but I have since come to appreciate as a possibility.

COM. NEWMAN: Thank you.

MR. PASQUALETTI: So here is just a summary and conclusions. And then I would be happy to take any questions.

The idea of virtual water, export water when we export electricity, I think it is an important concept to keep in mind. It is not to say we don't export with other things. We do with crops. We send our cotton abroad. We do all sorts of things. But it is something to think about, because when you are, when you are growing crops, you are including the water cost in the cost of that crop. The question would be, when you are making electricity, are you including an adequate cost of that electricity in the cost of your electricity, the cost of the water in that electricity. I don't know if that's true.

COM. NEWMAN: I think we do.

MR. PASQUALETTI: I don't know if that's true or not and certainly it is worthy of more detailed study of

this.

COM. NEWMAN: Interesting.

MR. PASQUALETTI: Technology, I think the technology is available. We can do dry cooling with conventional, dry cooling with solar. We can do a variety of ways to cool these power plants and use much less water. But, as I said, there will be at least two penalties that you will have to pay.

Merchant plants, the question I raised before, is the question of net benefit. When you add in everything, I have never seen a cost/benefit analysis with these merchant plans. Certainly they provide tax money, they provide jobs, they do a whole variety of things. Do they do enough to compensate for the water loss, that's another question.

And then renewable energy, there are some encouraging advantages. Solar, concentrating solar power certainly will use a fair amount of water. As I said, there will be ways to make that dry system, but that will have to come after they make sure they can do all this economically without the dry system in Arizona.

So, but what I am thinking is, and this is an interesting kind of comparison, is that if you take the first stage of solar in this state, I don't think there is going to be a problem because the first stage of

solar -- like the Solana plant is going to be on land that's in alfalfa. Now you are going to take the alfalfa out of production and put solar in production. You are going to save about 80 percent of the water. So what is going to happen I think in the first phase, from a policy perspective, is to allow the solar power people to go on land that already has the water associated with it, remove that from agriculture and dedicate it to solar, saving about 80 percent of the water in the process. That way you get the electricity, probably make more money off the electricity, and use one fifth the water.

COM. NEWMAN: Just a quick --

CHMN. MAYES: Well, let's have him wrap up and then we will start with questions.

COM. NEWMAN: Okay.

MR. PASQUALETTI: Then the subsequent stage, I think that there is a potential problem. Then third, PV solar is favored because of its low water use. And there is a very strong interest in photovoltaics of course. The CSP -- of the 30 plants that I saw that were on BLM land proposed in Arizona, I think only one or two were photovoltaics. Most of them were CSP.

So when we get to the point where it is cost effective, and I think once we get to, this is key, this

is what I talk to my students about at length, once we get the external costs internalized in the rate base for the conventional sources of energy, it is going to narrow the cost gap between renewable and convention. Right now there is a big gap, or there is a substantial gap. But if you can, in fact, include a value for the water not used, and if you include the external costs for the other that solar does not have, you narrow that gap to where you are within striking distance. And that's something that I think is worth pursuing as well. And then emphasizing the external costs I think will favor water, sorry, would favor solar because, in fact, solar has so few of these.

Some people would say that it takes up a lot of land. I have done studies which some would argue that's not the case. And we can talk about that if you would like. And solar desalination can improve water supplies and they can improve them in stages. You don't have to bring it from the worst water to the best water. You can improve the water to agricultural quality and the agriculture water to drinkable water.

So with that, I would like to close. And I would be happy to answer any questions. And if you have any time or you would like to hear from Professor Ruddell, he can speak to you about water and the urban

heat island as well.

CHMN. MAYES: Thanks, Dr. Pasqualetti.

Commissioner Newman.

COM. NEWMAN: Yes, a couple questions. Well, on the issue of, and I certainly agree with you that building this solar facility on, or for that matter any power facility, on agricultural land makes sense. But this is the -- because I have been dealing with this for a number of years as a supervisor and now as a Commissioner, some of that land is not being used at all either because of, you know, government programs for subsidization or just because we don't need as much alfalfa. And so, you know, what do you do about that?

I am asking a strange question. Retired agricultural lands that will never become agricultural land again, we have so much dedicated to it, is it really a savings if that piece of land has just been sitting out there waiting to become the newest Buckeye?

MR. PASQUALETTI: Commissioner Newman, there is multiple parts to that question. Oftentimes the agricultural land has water rights associated with it, so you could rededicate or repurpose those water rights and release some of the water back. The people who have the water rights usually use that water for something, selling it, because it is so valued. So you could take

that out and repurpose that for something else.

But for the foreseeable future, there is so much land that is being used for cotton, for alfalfa, I would say that whole corridor from Gila Bend all the way to Yuma, you could put solar in most of that, on a lot of agricultural land, apart from all the political ramifications of course of trying to do that. But there is, there has been no shortage of landowners interested in talking with solar developers. They certainly are all aware that they can make money by selling that land or even leasing that land and their water to solar developers.

COM. NEWMAN: I talked to a lot of my ag business friends, and there is a love/hate relationship also. They are very, very -- how do I say it -- protective of that land, whether it is for future water rights or cultural reasons, of keeping a strong agriculture business economy or for economic reasons. That has been my experience in trying to talk to my fellow Arizonans who represent that business.

MR. PASQUALETTI: Chairman Mayes, Commissioner Newman, I think that there is, there will always be some pushback from some people. But the income that they can generate from electricity will exceed, I think in most cases, what they can make from their agriculture.

Moreover, the agricultural land is already disturbed land. You don't run into a variety of endangered species act problems. There is a permitting procedure less arduous for land that has already been disturbed. But there are a variety of other reasons for doing this.

There is a big temptation in Arizona because we have 110,000 or so square miles and everybody says, gee, there is plenty of land, why don't we put solar everywhere. And then when you try to do it, people decide there are reasons that they don't want to do that.

I think we have actually turned that corner. I have been waiting for years for this to happen. I have been here since 1977, and every few years people say I think we have turned the corner. But I think we might have actually done that this time. I see people spending serious money doing this. The business world is saying this is a cost effective way of making electricity.

Now, of course, there are incentives. There are investment tax credits and so forth. But that won't stay around for long. And I just see an enormous enthusiasm for solar energy development in Arizona. And one of the attributes of solar is, for the most part, they don't use the water that other sources do.

Can you make enough solar electricity to offset what you need from or get from another power plant, that's another story. I mean clearly you could if you want to cover enough land. Do you want to do that?

There are other ways to do this. I think that there are ways to do infilling with solar that we haven't taken advantage of. We could have many hundreds of megawatts within the infilled area on existing parcels in the Phoenix area. There are ways to do that.

COM. NEWMAN: I absolutely agree with you.

MR. PASQUALETTI: And I know that, I believe that, if I understand and people may be able correct me, I believe APS' demand is growing about 300 megawatts per year. And that, I mean that's a big chunk. And if you talk to other people, like Southwest Energy Efficiency Project, they will tell you you can get that by energy efficiency. And you certainly can do a lot of that sort of thing. So there are alternatives besides going with the same path. And I think, once you include the external costs of going down the same path and you include those costs, then the margin of difference in the cost between renewables and nonrenewables is largely eliminated.

COM. NEWMAN: The only other question I had, I am just limiting it to one other question, there were

many questions that your presentation brings into mind, but I thought I saw a graph. There was a presentation earlier by APS that showed how much water was being used in an ag business struck area. And it showed, it was a big, big fat piece of the circle. And I invite my APS people, friends to respond to this, but you said a statement earlier and I am trying to think whether they meshed, that 40 percent is used for energy and 40 percent for ag water. I think that's what you said.

And it seems -- I don't know if the, if the two models mesh. And they don't mesh. I just picked it up. And I just don't know why they are not meshing. And I invite you to explain that, and APS.

MR. PASQUALETTI: Commissioner Newman, I can explain that. The number of 40 percent is a national figure, is a national figure.

COM. NEWMAN: Oh, I misheard you then.

MR. PASQUALETTI: The vast amount of water used in the state is irrigation.

COM. NEWMAN: Okay.

MR. PASQUALETTI: It is very high.

CHMN. MAYES: 60 or 70 percent.

MR. PASQUALETTI: At least it is 40 percent. I was just putting that up there to emphasize that nationally it is becoming comparable for thermoelectric

power plants and for irrigated agriculture national. I should have clarified it was national.

COM. NEWMAN: You may have said that; I just missed the word. Thank you so much.

CHMN. MAYES: Okay. Commissioner Stump.

COM. STUMP: Thanks, Madam Chair.

Professor, I have I suppose what you might call more of a meta question as it were. And again citing a fellow at the Pacific Institute, Peter Gleick, he said something that struck me. He said it is inevitable that we will solve our water problems; the trick is how much pain we can avoid on that path to where we want to be. And he distinguishes between, I guess, degrees of pain, hard path solutions and soft path solutions.

A hard path solution as he sees it involves gaining new supplies of water, the super sized dams, aqueducts, pipelines carrying water long distances. And the soft path, which he sees as the more comprehensive approach, involves things like better conservation measures, better measures as they relate to efficiency, improvement on community scale infrastructure, management of watersheds, et cetera.

And he cites Albuquerque as an example of the soft path approach. Until the mid 1980s, hydrogeologists evidently believed that there was a

reservoir underneath the city as big as Lake Superior, quote, unquote, and supreme lawns were ubiquitous. And unfortunately they discovered that the aquifer was not nearly as big as they had expected. And so water use codes were instituted, rebates for low flow fixtures and the like. And domestic per capita water use declined from 140 gallons a day to 80.

And so I was curious, and maybe this is a false dichotomy, but I wondered if you favor one approach over the other, a combination of soft and hard, or both, perhaps both are essential for Arizona to move forward.

MR. PASQUALETTI: Chairman Mayes, Commissioner Stump, I actually favor the combined approach. I think that they both can push one another. I am interested in one pushing the other. That is, the soft approach is nice.

If you look at it from the standpoint of electricity, I think that electricity in the conservation of electricity is different than the efficiency of electricity. So I look at energy efficiency as technical and conservation as behavioral. You flip off the switches when you are going out, that's conservation. The lights go off automatically, that's efficiency. I just like to make that distinction.

But I think that's kind of the soft path and the

harder path. You can, I think, do both of those. I have seen it happen in Las Vegas as well. I am sure many of you have been to Las Vegas and you know how aggressively they have been taking out turf there and paying for taking out turf. I think Albuquerque is a perfect example of moving in that direction. We can do that as well. We can do that as well.

But there is some very nonsensical ways that we use water. And all of you know these, I mean using the same drinking quality water to wash our cars, wash down our pavement. It is just a crazy system. And many other countries don't do that. The first time I lived in England, for example, people told me only drink water out of the tap, out of the mains they call it, which is the sink. All the rest of the water you shouldn't be drinking in the house. So they had two different supplies of water. We can do that, and we probably should do that.

Mostly we can do that in a fast growing area like Phoenix has normally been, we can do that in all new housing structures. You put in codes, we are going to have a separated system and we are not going to use water that way. If you want to save water, that's probably the fastest way to save it. But there will be technical ways within that answer and there will be

behavioral ways within that answer.

COM. STUMP: And to that point, Madam Chair, the idea of dual plumbing, and I don't know how widespread that is, but as I understand, I understand there is one line for potable water, another line to recycle the less treated water for toilets and lawns and all the rest. And I think Albuquerque was looking at that last I heard. And I don't know how widespread that is or how many municipalities and such are looking at that, but interesting idea.

CHMN. MAYES: Yeah, and I agree with Commissioner Stump about that. It is really fascinating the way that you put that and/or, I guess, you know, Peter Gleick puts that. And I appreciate you bringing it up, Commissioner Stump. It sort of frames it in a, I think, a different way. And I think it is, that's valuable.

And, you know, dual plumbing I think is something we ought to look at. It is purple pipe to the home, purple pipe to the outside of the home, especially in new construction. Only one of our water companies is doing that, or even planning on doing it. None have actually done it. And only one city, I think Tucson, has done it. There is only a couple neighborhoods in Tucson that have done it. But I think it ought to be

done everywhere, frankly, where there is new construction. But that may be a discussion for another day.

I just have a couple final questions, Dr. Pasqualetti. One is you talked about using ag land first. Well, let me ask you about this. We talked about the IPPs. You posed an intriguing question. Are the independent power providers, are we requiring enough from them for the right to use our water and export power for them to profit from exporting power primarily to California?

Obviously there are some huge interstate commerce issues there, and I don't want to -- we are not at the law school right now. But I do -- it does pose an interesting question for this Commission, which is increasingly being asked to site and approve solar plants that will largely be exporting power to California because of its much larger renewable portfolio standard.

As you know, California has a 33 percent standard; Arizona has a 15 percent standard. And APS doesn't really need to build any more large scale solar plants or purchase power from any more large scale power plants to meet their requirements under our current RPS, which basically means that all these power plants, solar

power plants, that we are siting today will go to California. They will be here. And if they are CSP, they will use our water to export to California.

I philosophically have not necessarily been opposed to that. I think there are all sorts of benefits associated with having these projects here, including the upfront jobs and the supply chain jobs that might be attracted to Arizona as a result of that. But how do you think -- you obviously think that there ought to be some --

COM. NEWMAN: Value.

CHMN. MAYES: -- yes, I guess value extracted, if you will, from the independent power producers that are traditional natural gas, combined cycle plants. Do you think the same should be said of solar plants? Is there some demarcation between those two that makes them different or --

MR. PASQUALETTI: Madam Chair, to me it is -- being at the university, I want to study these things first. I would like to find out what it is that -- what is that incremental cost associated with that, what is that cost associated with this, both for conventional and for solar. It is fair game. We are trying to level a playing field here. But including external costs, we are trying to level the playing field, should work in

both directions. And certainly what I would really want to see, I just want to see this level playing field for all.

If you, just as a point of argument, take out the subsidies and all these various different systems, whether it is coal subsidies or nuclear subsidies or solar subsidies, and you level that field and then you compare them, I would be very interested in seeing what that would be like, especially once you include the external costs, the visibility costs, the health costs, health and transportation costs, a whole variety of other, long-term waste disposal.

I worked on nuclear decommissioning for years and saw nuclear waste disposals. And I know there are huge costs right there that right now are not being absorbed by all the companies. So it is -- and it goes on for a very long time.

So I would like to level that field, compare them all, and then see where we are.

CHMN. MAYES: Okay. Thank you, Dr. Pasqualetti. And one last question, then we will take some comments from your colleague. We appreciate him coming as well.

You mentioned ag land. Increasingly, as we site these solar projects and as we site power lines, we do both here, it seems to me that we ought to be thinking

about the siting of power plants with a view toward where that ag land is, quite frankly, I mean just to get to the bottom of it. At bottom, we know where a lot of the ag land is. It is between Phoenix and Yuma and between Phoenix and Blythe. And I am wondering -- and, you know, we have existing power corridors in both of those areas.

And so I wonder, have you given any thought to that, about the siting of transmission near ag land? I mean we talk a lot about siting transmission near where solar projects have requested interconnection. But I am wondering if we should even be taking a step further and be driving that solar interconnection into these ag areas.

Commissioner Pierce talked about it earlier today. You have talked about it today, where we know, you know, we know we want the phase one stuff to go there. We know we ought to be exhausting the phase one stuff before we, again, get to the phase two stuff, which is where we are going to be getting so much pushback from environmental people and BLM and Game & Fish. So shouldn't we really be looking at power corridors that really run through both the agriculture and solar heartland of our state.

MR. PASQUALETTI: Madam Chair, I think the

Western Governors Association and many other organizations have been looking at the placement of transmission lines vis-a-vis the renewable energy availability in the western states. I don't know that they have been specifically calling out the agricultural land as something that is of influence.

CHMN. MAYES: We haven't. I sit on the committee. I go to all the meetings, many, many, many meetings. And we are not. But I think we have the opportunity to do that in Arizona because we have our transmission planning processes. So any thoughts that you might have on that would be obviously welcome.

MR. PASQUALETTI: Well, when I have some thoughts I will certainly share them with you.

CHMN. MAYES: Okay, great. Sounds good. Listen, why don't -- thank you very much for coming. We really appreciate it.

MR. PASQUALETTI: Thank you very much.

CHMN. MAYES: And, particularly, I mean all the slides were fascinating. And are those available on ASU's website or is that something you can share?

MR. PASQUALETTI: They are on your desktop, and you can take that if you would like.

CHMN. MAYES: Thank you very much, appreciate that.

All right. And we are going to take about a five- or ten-minute break right now.

(A recess ensued from 2:53 p.m. to 3:07 p.m.)

CHMN. MAYES: Let's come back into session. I know it is getting late in the afternoon, but I think we still have several Commissioners here and we have one last individual to speak.

And I apologize that we are so late in the afternoon but we would love to hear a few words from you as well. And if you could, say your name for the record.

MR. RUDDELL: Madam Chair, my name is Benjamin Ruddell. I am on the engineering faculty at Arizona State University. And my specialties where I do research are water resources, ecohydrology, which is the connection between water and plants on the landscape, and also energy and water connections. So I am a colleague of Dr. Pasqualetti, who just spoke. And I would like to offer just a few minutes of remarks. I don't have any slides for you. And I will be very brief and to the point.

We have a unique opportunity in the Phoenix metropolitan area not afforded to many places in the world that have trouble with water energy issues in terms of the need to use electricity to cool the city.

And that opportunity is the direct use of evaporative cooling of water to reduce air temperatures and thereby reduce the need to use and generate electricity for the purposes of air conditioning.

Now, I will just say right up front some of what I am going say is counterintuitive because we have gotten used to, in the last 20 years, the notion of saving water and reducing water use, and this being a good thing, but I am going to suggest that there is some research that has just been completed which may offer a counterintuitive point, which is that you can use water strategically in an urban area to actually save energy. And you can possibly even save water by using more water. Let me explain how that would work.

So there is a study that just came out, Gober, et al., 2010, the Journal of American Planning Association. She is a colleague of mine at Arizona State University, the director of the Decision Center to Desert City. And I spoke with her about this just recently.

That paper demonstrates that, according to some preliminary data that has been collected in the Phoenix metro area and some modeling that has been done, when you apply water to turf areas and to trees, you can decrease the air temperature in the immediate vicinity

of that water application.

The principle is very simple and easily understood. When you have solar energy or heat energy and thermal energy coming in, and you have in the atmosphere a deficit of water, in other words, you have a relative humidity below 100 percent, if you put water on a plant or on a surface of any kind, it will evaporate. The evaporation of that water takes energy out of the system and that's energy that doesn't go into heating the air. So it is evaporative cooling, and the more water you apply and the larger the green space, the greater the effect.

So there is some research going on at ASU right now which is aimed at demonstrating that effect and quantifying it and actually trying to understand whether this is an effect that can be scaled up. We all know that standing under a tree where the tree is evaporating water and shading us is going to cool us. But I think the really interesting question and the one that we are working on right now is the question of whether we can, as a matter of public policy, manage green spaces throughout the city, design and build them in and, in fact, use water to cool the city's air temperatures thereby reducing the need for air conditioning.

There is going to be a trade-off between green

space water use and between the cost of the electricity. And we are not exactly sure what that trade-off is. That's a very interesting question and one that hasn't been answered yet. But this is an area that I would like to suggest to the Commission, Madam Chair and Commissioners, that should be taken into account in the future and is something that's going to become important.

Now, here is a connection to Dr. Pasqualetti's work. I will just conclude with that. And it is well-known that for the generation of electricity we need lots of water. We just heard Dr. Pasqualetti give an excellent presentation on that for about an hour. It may even be possible, and this has not yet been demonstrated, but it may in fact be possible to save water for the city as a whole by using more in the urban center for evaporative cooling and avoiding the use of water to generate power or electricity at our thermal generation stations. So that's a very interesting question and one that may be on the horizon for public policy.

CHMN. MAYES: Professor, thank you. It is an intriguing, well, maybe provocative question that you pose. But certainly it is something that I have thought about from time to time as we, in many of our cases,

many of our water company cases, we talk about encouraging -- in fact, we have measures that we subsidize through our water companies that encourage xeriscape, for instance. So we are trying to get rid of the use of water for green things, I guess, for lack of a better more scientific term. We are trying to get rid of turf. We are trying to get rid of, you know, turf in front and backyards, those types of things, certainly golf courses.

And I guess, you know, one of the -- so is it maybe not a zero sum game? Maybe it is not a question of discouraging turf everywhere but rather encouraging turf in strategic places? Is that the -- is that what you are looking at?

MR. RUDDELL: Madam Chair, yes, I believe that's what the research is suggesting. And I think the most, the key issue in the research is whether you can -- let's say if you have a house 100 yards from a public green space that is being managed to cool urban air temperatures. What is the private benefit and the private reduction in electricity costs that is incurred from that public management? And to what extent can that actually be controlled by water companies, by cities and towns, by utilities? That's the really interesting point. And we really don't know yet.

CHMN. MAYES: How will you know? How do you scale it up? Obviously you can't scale it entirely up or else you are going to cause a lot of heartache to a lot of people who probably aren't going to want you to be running around putting turf in everywhere. How do you test that from an academic standpoint.

MR. RUDDELL: Right. That's a good question and one I can talk about for hours, but I won't. I just wrote two proposals on that.

CHMN. MAYES: Can we get credit for this? Go ahead.

MR. RUDDELL: As the number of federal funding agencies have recently heard from myself and my colleagues, you can test it through a combination of techniques. You can use aircraft where you are flying over the city and taking high resolution thermal imagery. So you can see exactly what the pattern of air temperatures is on the landscape. And then you can compare that with evaporation patterns.

You can also do something a little more direct. I am working on an experiment in the east valley where in a large master planned community that has a lot of turf and tree area, fairly typical of the valley's communities, we are going to be measuring the water application to the plants and turf directly and then

measuring humidity and temperature levels on transects through the community. So we will be able to directly measure the effect of water application in one location to air temperatures and humidity levels throughout the community and we will be able to directly model and measure that effect.

CHMN. MAYES: I think from the context of what you said I understand what transects are, but what are transects?

MR. RUDDELL: Yes. Transect is a technical term for an experiment where you design a -- you would measure, take measurements along a line or along a grid. So I would take a temperature measurement in the middle of the park and then I would take a temperature measurement in someone's front yard a little bit away from the park, and then a little bit further. And that would allow me to separate out the effects of the distance and the different land cover types. It is a way to design experiments.

CHMN. MAYES: Commissioner Newman.

COM. NEWMAN: Yeah. Thank you, Madam Chair.

It is interesting and provocative, what you are saying. A couple days ago on Monday morning I took a walk over to Sabino Canyon down in Tucson. And the air temperature probably out in the general area of midtown

Tucson where I was was around 80. And over in Sabino Canyon it was probably around 65, especially close to the water source that was coming down the creek in the Sabino Creek. And not only did I find it exhilarating, I found it lovely. And I said to myself, well, this is what, you know, this is how God meant it to be in Arizona, you know, when the water is running.

And it concerns me that around 80 percent of these riparian areas had been destroyed in the last 100 years, a lot of them by the pioneers of Arizona, some of whom were the power companies of Arizona and all of the, you know, the planners that, quote, unquote, planners who weren't really planning but just basically developing what was in front of their faces, which is understandable.

But so a natural sort of experiment of what you are saying is look at a riparian area and how much cooler and more delightful it is, is that correct?

MR. RUDDELL: Yes, in brief, that is correct.

COM. NEWMAN: And so since I can't restore, you know, those 80 percent of the riparian areas in Arizona that have been restored, urban planners such as yourself are saying we can't restore them either, maybe we can, maybe we should, but we should also try to do something with our urban planning and take some of the heat island

effect off of all of Phoenix and our two major urban areas of Tucson and Phoenix by making us greener in that inner core. Because when it gets red hot there when it is 120, that has an effect all over on temperatures, doesn't it?

MR. RUDDELL: Yes, Commissioner, I would agree.

COM. NEWMAN: So what you are saying is not necessarily, you know, anti-intuitive. It might actually be very intuitive, like we are bringing back many riparian environments through grass or turf in places where people live now.

MR. RUDDELL: Uh-huh.

COM. NEWMAN: We are ripping up the parking lots and putting in greenbelts.

MR. RUDDELL: Yes. I think there is some interesting policy implication here. It is going to take, I think it is going to take a little bit of time for that idea to catch on.

COM. NEWMAN: I would say so. No, in terms of planning, it will, because it is hard, it is hard to have the leadership to do that.

Also, it occurs to me, I was always fascinated with this, Salt River Project inundates whole areas of this city and their surrounding areas with excess water and they make like little lakes in people's backyards.

I wonder whether that's the best use of water. But that is a form of greenbelting, isn't it?

MR. RUDDELL: That's correct. In fact, open water areas are going to have the greatest effect on the air temperature surrounding them because they evaporate the most water. And depending on your perspective, that could be the largest waste or the largest benefit.

COM. NEWMAN: That was the last thing I wanted to talk to you about. I guess, because we were talking about it, I think we can talk all day about this, but is that a waste or is that a benefit? When I see it, it feels like a waste. But you are telling me I am being anti-intuitive, it may actually have a benefit in some way.

MR. RUDDELL: Commissioner, I think the question, the research question that needs to get answered and a possible policy question is whether we can and whether we should use that type of water evaporation for public benefits on a citywide scale, because that would benefit everyone. And in that sense it would not be a waste.

If you are looking at an economic sense, you could compute those trade-offs in terms of the costs of electricity and water. You might also have some positive externalities, meaning benefits occurring to

other areas. For example, if we are applying water to the city and avoiding power generation outside the city and that frees up water in those other areas, it might allow greater stream flows, for instance, riparian areas.

So it is a complicated system and that's why very detailed and thorough work like you saw from Dr. Pasqualetti needs to be done. But it is a very interesting question. And I think you are raising some interesting issues.

COM. NEWMAN: And it is the externalities of that, the values. You have to put money value on that cost of water. Right now it is relatively cheap. I think like the price of gas, it would probably go up, with the change of temperatures, water might go up as well.

So that, so the externality values could change over time if greenhouse gases exacerbate our water situation, is that right?

MR. RUDDELL: Commissioner, I would agree.

COM. NEWMAN: The only last thing I would say, there is a place in Maryland, greenbelt in Maryland, in Columbia, Maryland, where they actually did what you are kind of talking about. They made little areas in town full of trees and grass and other areas that use more

conserve -- conserve more water. But in general those towns that have these greenbelts are, you know, the nicest places to live. And like you said, they even have an effect of keeping water in and maybe retaining some of those creeks that run in those areas. So there is something about actually maintaining riparian areas that you are talking about, isn't it? Could be.

MR. RUDDELL: I think that's a possible connection. It is, a riparian area could be used as a tool, as a policy tool for achieving this air temperature reduction in much the same way as a turf area or tree area could.

COM. NEWMAN: One last thing. On the CAP canals that go all through this city, and water is evaporating all the time out of them, is there something that the CAP planners can be doing to sort of make it not cooler but, you know, cool, cooler in Tucson by using that water in some way, or is that a question you have ever thought about?

MR. RUDDELL: I haven't thought about it or studied about it so I should probably not comment on it.

COM. NEWMAN: I saw a plan to have areas of the CAP canal as it rolls through places like Indian School and northern Phoenix as a place where there can be solar and places to sit outside and just enjoy the coolness of

the CAP canal. Interesting, though.

MR. RUDDELL: I think so.

COM. NEWMAN: Thank you.

CHMN. MAYES: Thank you, Professor Ruddell, appreciate you being here. And was it Professor Gober that you had mentioned has written on this topic?

MR. RUDDELL: That's correct.

CHMN. MAYES: I would, we would love to see her work and work that you come up with as a result of this study that you are currently undertaking, if you would be so kind as to send that to us.

MR. RUDDELL: Madam Chair, I will send you two specific papers, maybe a few others.

CHMN. MAYES: Great. That would be terrific. Thank you very much.

COM. NEWMAN: You have been great. Thank you.

MR. RUDDELL: Thank you.

CHMN. MAYES: Okay. So, colleagues, we are almost done. Why don't we call for public comment or a response to anything we have said so far.

I don't know. Does anybody want to say anything about what we said so far? Yes, Mr. Walker.

If we could get him a microphone, that would be great.

MR. WALKER: I can walk up.

CHMN. MAYES: Oh, great. Thanks, Paul.

MR. WALKER: Thank you. Paul Walker, Insight Consulting, Phoenix, Arizona. I just wanted to respond to one thing Professor Pasqualetti referenced.

He said Arizona exports about 29,000 acre feet a year of water for electricity. And he uses the analogy that would be approximately what Tempe uses. Tempe's most recent resource plan for 2006 says, quote, Tempe's 2010 water demand is about 65,000 acre feet per year. And analogies are important. They stick in our head. So I wanted to clarify the record on that point.

CHMN. MAYES: Okay.

MR. WALKER: Thank you.

CHMN. MAYES: Thank you, Paul. Would anyone else like to make any comments on what was, what we have talked about this afternoon?

(No response.)

CHMN. MAYES: Okay. We don't have all the Commissioners. Several Commissioners had to leave early today. But I just want to throw something, an idea out there. We do have several utilities still in the room. So maybe if I could just offer this idea, this thought for the bench and for the utilities to think about.

I thought it was a fascinating day. And all of our workshops are productive, but I thought this one was

particularly productive in the sense of providing information and, at least in my mind, sharpening the notion that we can put a price on water. And I think we can do it pretty easy. Of all the externalities that we have, I think water is going to be the easiest one to price.

So, and I am personally interested, I mean I think we should have done this before now, and I am personally interested in seeing this be done and be done in a way that's timely enough for our 2011 implementation plans. So let me propose that we continue to work on externalities, have these externalities workshops. But I would like to see the utilities engage in the next 60 days a process by which they propose a price for water, for the externality that is water, or put it another way, an externality price of water --

COM. NEWMAN: Monetization.

CHMN. MAYES: -- a monetization of water, and allow input from other stakeholders.

So I guess the process that I am proposing to my colleagues and to the stakeholders is that you engage in a process that is similar to one that is being used in our BTA process by which you would work together and propose a number to the Commission. That would be plan

A.

Plan B would be a very much more extensive and Commission supervised workshop process and Commission driven process.

So that's something probably that we would need to discuss. I would like you to just think about that. And if we, if we need to, we can put it, probably would need to put it back on a Staff meeting so we can all talk about that.

Yes, Ms. Ormond, is there something you would like to say? And actually I would like to get the feedback of stakeholders and the utilities to this idea.

MS. ORMOND: Just a clarifying question.

CHMN. MAYES: If you could grab the mike, because on the off chance that someone is still listening to us out there.

MS. ORMOND: Madam Chair, Amanda Ormond, Interwest Energy Alliance. A clarifying question. 60 days and showing a price of water to show up in the integrated resource plans that will be filed?

CHMN. MAYES: No. I was thinking -- good question -- although it would be in the IRPs, but also the energy efficiency implementation plans and renewable energy implementation plans, especially the EE cost test. We heard from, and I believe this is true,

Mr. Schlegel pointed out that some of those tests current -- some of those programs currently have a zero cost of water, which is ridiculous.

MS. ORMOND: Right. And any guidance from the bench how that would be calculated or what types, avoidance of water?

CHMN. MAYES: No. I am going to leave that to you to think about. But that's something I think that I am looking for feedback from folks. And I see people putting their heads together.

MS. ORMOND: Okay.

CHMN. MAYES: Mr. Schlegel.

MR. SCHLEGEL: Jeff Schlegel, SWEEP. Thank you, Madam Chair, Commissioners.

We would support that, that approach. I think it is a good approach to try to have an informal process where people can work together and bring something to the Commission. I know the Commission has a lot on its agenda. So do the utilities and so do many stakeholders. A formal workshop process could also work but it might actually be faster to do an informal process and bring something before the Commission that the Commission can chew on in terms of, you know, of a proposal.

I very much like that idea. I like that you

have included the opportunity for stakeholders to have input into that process but the utilities to have the responsibility to bring you something. That sounds like the right balance to me on the input side of the -- side.

And we would really, SWEEP would like to encourage the Commission to have these values certainly show up in whatever dockets or proceedings are coming before you where they are relevant. Definitely the energy efficiency implementation plans could be considered for things like the renewable energy implementations, the next round of those, you know, and/or the resource planning processes. I am not sure which one that will be first for which utility but we would encourage moving forward with it, again, moving off of zero, moving forward to some value for water that could be included in those proceedings. Thank you.

CHMN. MAYES: Yeah, Commissioner Newman.

COM. NEWMAN: I also, I second your idea and your proposal. What I was going to say was that I was going to say something about how this started out.

I was talking to a gentleman the other day who used to be on the Commission, Mr. Jennings. And this was supposed to be taken up by the Commission. The subject of externalities and costing was supposed to be

done, not supposed to be done, was going to be done in the late 1990s and everything sort of dropped out after the deregulation plan went through the legislature. And the Commission dropped it from its agenda. So I think that this whole discussion is sort of ten years overdue.

And so while your proposal is quicker than I thought, I back you on your idea that water is a very, very important variable that we should look at quickly and/or at least just think about quickly. You know, coming up with the exact monetization can be very complex. And I am -- you know. But I look forward to the process. But I see some people in the room a little surprised. To be honest with you, I am surprised at your proposal. But I back you and instinctively think we should talk about it quickly as opposed to, you know, five years from now, because we are already ten years behind.

CHMN. MAYES: I think you make a good point, Commissioner Newman, that this has been a ten-year-old discussion. And I wouldn't make this proposal, you know, I didn't come in today thinking I was going to make this proposal, to be honest with you. It was really the discussion that we had this morning and frankly something that Mr. Guldner said that just sort of turned the light bulbs on for me. When he said that,

you know, that this is truly the externality that is easiest to price, I thought, well, you know, I mean the utilities think it can be done, then it could probably be done. And if the utilities are willing to say that it can be done, then it could probably be done.

So I would like to start out by giving the utilities and the stakeholders the opportunity to do this. And if they can't get it done or if they don't want to, which I doubt that that would be the case, but if they don't, then the Commission can drive the bus. But I would like to -- we have always -- I think the processes that have moved forward this way in my tenure with the Commission have always been best when it is -- it has always been best when it has been done that way. And that's what I would propose.

Now, maybe we should bring this back to a Staff meeting discussion because we don't have a full complement of Commissioners here to talk about this. But, you know, I am not talking about carbon right now. We will get to that, I am sure, at some point. I am not talking about NOx or SOx or mercury or those emissions. I am just talking about water right now, just water. And I think that's something that we can bite off little bite sized, a little bite that we can chew right now and get done maybe in the next few months. So that's what I

would propose.

And, Mr. Dion, do you want to give us your thoughts?

MR. DION: Absolutely, Madam Chair, Commissioners. And Phil Dion, for the record, UniSource Energy.

I think the discussion also highlights something that goes back ten years as well. And that's the integrated resource process. The Commission also got away from that as well. And I think that some of these discussions are incredibly relevant in that process because there you do get all the stakeholders. You get the utilities. You get everybody involved. You get the Commission involved and everybody becomes engaged and we begin to understand what the resources are going to look like in the future with some of the rules of the road, not all of them, but with some of the rules of the road that are there.

And one of the things that we have encountered especially in energy efficiency is the societal cost test. And there is a difference of opinion as to what that societal cost test is and isn't. And I think once we figure out what that true societal cost is, which includes various elements that the Commission talked about for instance today, it does or it doesn't, once we

go there we will be able to put together programs and resources, and not make a prudent review of but to say, yes, this is the direction that we think Arizona should go into. And from that the utilities can make some informed choices.

So I think going back all the way to that, I think that's a crucial thing. And I am glad this Commission has taken this up again, because that is extremely important.

The one thing I would point out just for your consideration, Commissioners, if you do discuss this in a Staff meeting, I would just establish a docket. I would establish ways to intervene or participate. Because the last thing I want to do is get through a process like this and find out a party who was interested didn't have that opportunity or didn't know about it. I think we do want to have those discussions and we want to have it in a way that everyone can submit information into a docket or be a participant. Because when we talk about having something in 60 days, I want to make sure that we are able to get all the folks that we have to in Tucson or up in Kingman or wherever we are going to have these discussions, and that we don't -- and at least we give people the opportunity, I can't make sure everyone will participate, but just that

opportunity. So just a procedural mechanism, Madam Chair, would be my suggestion so that we can get moving on that.

And then from that, from that decision from the Commission, then those stakeholders can get in touch with each other and participate and get to that ultimate result or that beginning point that the Commission is interested in.

CHMN. MAYES: Okay. Thank you, Mr. Dion, for that suggestion.

Mr. Dinkel.

MR. DINKEL: Thank you, Chairman Mayes, Commissioners. Pat Dinkel from APS.

Chairman, Commissioners, I will echo a few comments that have been made. I certainly appreciate the expediency and interest. I will tell you from APS' perspective, we were very much looking forward to these workshops, as well as a number of other workshops, proceedings as well, and our own workshops that we are holding starting with April 22nd on a resource planning process to really inform us on the right sort of both analysis as well as sentiment on these various topics.

So probably my primary concern with the 60-day window is it would almost force us to put forth a fair ly expedited position on this, that, quite honestly, I

was looking for a little bit more informal. I thought today was very helpful. But I think some of the trade-offs we were talking about and the urban island is a good example. You are trading off everything, you know, water to comfort to electricity to jobs. There is a lot of complex trade-offs here. And I would like to see that vetted through a public process. And I am afraid if we try to jump start in 60 days, I am afraid it would be a little too fast, and I don't want it to be a utility led initiative that we are kind of trying to force down. So I like the point of let's go through a little bit more of a public process, have a little bit more discussion on this.

You know, obviously we are always bringing up the trade-off between the various resources and customer impacts. I know you care about that. I know you want to see that. Adding water, as we talked about today, doesn't just reduce a gap potentially between conventional and renewables. It could also raise the cost of renewables and conventional that use a steam cooling process. So we would like to be able to make sure we vet all these different issues.

60 days in a utility led process is just not what I had in mind coming in today. But certainly I am interested in trying to put some cooperation in that and

prefer to do it more in a little more public process.

CHMN. MAYES: I wasn't suggesting anything but a public process. I was just suggesting one that didn't take a year. I just don't think we need to take a year. I think it is outlandish that we don't have a cost, a price for water built into all of our energy efficiency programs.

And I totally agree with you, Mr. Dinkel, about, you know, the fact that we need to think about some of those sorts of issues that are at the 80,000 foot level. But I don't know what that has to do with putting a price on water and calculating that into or injecting that into our energy efficiency cost test.

You know, you would agree with me that having a zero cost of water is ridiculous, wouldn't you?

MR. DINKEL: Well, it would be. I would argue we don't have a zero cost of water because we do in fact take the cost of what it takes to procure water for generation. I am not trying to be difficult. It is not zero. I absolutely understand the perspective that it doesn't reflect the nonmonetized portion of the water cost. There is no question about that. And that's where it becomes a little bit of science and a whole lot of art.

CHMN. MAYES: And we will end with this and

something that I think the Commissioners need to think about. But I do intend on pushing this a little bit. But it doesn't seem to me -- well, lost my train of thought.

Oh, what I was suggesting was that, you know, the utilities, the stakeholders gather together over the next 60 days and take a first stab at it basically to come up with something that the Commission could look at and could vet. Then also in a public process, I wasn't necessarily suggesting that we come up with the perfect number, but it seems to me a number is better than no number in this instance, especially when we have been talking about it for a decade or more and we live in Arizona, Ar-i-zo-na. So I don't know, that was just my sense. We will talk about it at a forthcoming Staff meeting. And I appreciate your position on that.

MR. DINKEL: And, Chairman, we certainly have opportunity with our upcoming workshop April 22nd to raise this with the stakeholders that will be there. So we certainly look forward to being engaged with this and obviously do it in the way that meets all our needs.

CHMN. MAYES: Let me ask you this. How do even do an integrated resource plan without monetizing water, without having a monetization of water?

MR. DINKEL: There is no question that there is

some very important assumptions on what it cost the various things.

The other issue is, and, you know, I will say, while I have a finance background, I am one of the first people to say you can't monetize, try to put dollars on everything. You become too mechanistic and it misses the real value of what we do as human beings.

And so I look at anything that we do, as I have talked to you and the other Commissioners over the years about our procurement on generation, I will be one of the first to say you cannot try to just try to look at the numbers or dollars or pounds or whatever. And so I will say, while we monetize the explicit cost of water in our resource plan historically, we understand there is an interest in monetizing externalities but we also understand there is a whole lot of things that go into resource planning that aren't just numbers and dollars.

CHMN. MAYES: Okay, thank you.

All right. Does anyone want to add anything to that discussion?

(No response.)

CHMN. MAYES: No. All right. Thank you, everybody, for being here. It has been a great day. And we are, unless my colleagues want to add anything --

COM. NEWMAN: Happy Friday.

CHMN. MAYES: Happy Friday. We are adjourned.

(The proceeding concluded at 3:44 p.m.)

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

I, COLETTE E. ROSS, Certified Reporter No. 50658 for the State of Arizona, do hereby certify that the foregoing printed pages constitute a full, true and accurate transcript of the proceedings had in the foregoing matter, all done to the best of my skill and ability.

WITNESS my hand this 19th day of April, 2010.

Colette E. Ross

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